POWER

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ELY C. HUTCHINSON, *Editor*

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Buyer's Policy

A company needed certain equipment for its power plant. Realizing that first-hand information upon design, operating characteristics and installation requirements could best be obtained from a builder of the apparatus, a leading manufacturer was called into consultation.

The manufacturer, conscious of the compliment, and thinking of the preferential position of his company with respect to the inquiry, entered wholeheartedly into the discussions and gave freely of his time and that of his organization to evolve a highly satisfactory working plan. This done, the details settled, it was the buyer's next move. And this is what happened.

Said the buyer, "You understand, the regulations under which we operate state that we shall obtain at least three competitive bids, so now that the engineering is all settled, we must issue specifications for formal prices." This was done with the result that a man utterly ignorant of the engineering requirements, but a good pipe fitter, was able to assemble and connect the necessary parts at such a low price as to receive the order.

The legitimate contender who made this possible found himself on the outside looking in, and with only the lugubrious regret of the buyer for his labor.

Manufacturers with engineering organizations cannot thrive as wet nurses for plumbers. Each is necessary in its honored place, but if enough purchasers took advantage of price only, to the extent of ignoring the value of advisory engineering service, there would soon be no engineering manufacturers to consult.

EDITORIALS

Laboratory Tests Versus Service Realities

Are engineers worshipping too trustfully at the shrine of "scientific" testing? To meet the growing demand for precise information regarding the physical properties of engineering materials many new measuring units have been developed, and the testing laboratories grind out, in ever-increasing profusion, "facts" expressed in these units. This zeal for information is highly commendable, but is not the time overripe to apply a little scientific skepticism to the data thus obtained?

It sounds very satisfactory to say that such-and-such a steel has a "tensile strength" and "elastic limit" of so much—to say that its "creep limit" at a specified temperature is such and such. But the engineer must never assume, until his experience checks, that such data tell the true story of practice. Laboratory tests cannot ordinarily duplicate service conditions. They must attempt to crowd into ten minutes, or a day, the effect of ten years of unknown and unpredictable environment. The laboratory test result, in short, may be an unconscious fraud, unless the engineer takes it for just what it is.

This tentative nature of test results was clearly brought out in a paper which Prof. H. F. Moore presented recently in New York. No man is better qualified to discuss the testing of engineering materials. None sees more clearly the fact that these tests are rarely as "scientific" as they seem, and that correlation with performance results obtained on the job must be the ultimate measure of their usefulness.

Direct-Contact Heaters For Bleeder Turbines

Direct - contact feed - water heaters are those in which the feed water and the bled steam mix. They have been used for certain stages of bleeding on many turbines. This type of heater has been used for the deaerator stage of feed-water heating where it has particular advantages. A station was recently put into service where all heaters were direct-contact heaters and its performance will be watched with particular interest.

Direct-contact heaters can, in general, be built cheaper for a given service than closed heaters though this saving is offset to some extent by more expensive piping and pumps. The feed water is heated in each case to substantially the same temperature as the bled steam so that there is some gain in station heat consumption over the performance of closed heaters when used under the same conditions. With closed heaters, there must be a terminal difference of five to ten degrees Fahrenheit, between feed water leaving the heater and the steam supply to the heater. Direct-contact beaters can usually be arranged more conveniently around a unit than can closed heaters. Also, the direct-contact heater provides a ready means to deaerate the feed water.

While these advantages are of a substantial nature, the operating problems presented by direct-contact heaters must also be considered, since the feed water must be pumped from each heater to the next heater at higher pressure. This involves a multiplicity of pumps or a pump with a stage for each heater and to which pump all heaters are connected. The operation of centrifugal pumps in series when driven by separate motors and on variable loads, presents some operating difficulties and this combination of pumps with direct-contact heaters may be subject to similar troubles. Control equipment to overcome these difficulties tends to complicate the plant.

However, these operating problems are subject to correction and in the end the economies of the case will largely determine whether direct-contact or closed heaters shall be used. The former has characteristics that warrant consideration when analyzing designs for new stations.

Science and Engineering

Engineering is commonly assumed to be the practical application of pure science. Science, in turn, is defined as classified knowledge, based on measurement. Measurement presupposes standard units and instruments.

From this it might be reasoned that engineering practice is necessarily based on units and measuring instruments. This, of course, is no more than a part truth. For example, a boiler and engine could be built and operated entirely without such a background. Even a scale of inches could be dispensed with by the simple process of fitting one part to another, both being of unknown dimensions.

The case cited is extreme, but the simple fact is that much of engineering work is no more "scientific" than is the building of a rail fence by a farmer to keep the cows home.

Nor is this necessarily a criticism of engineering methods. Simple common sense, and nothing more, is often cheapest and good enough for some small job to be done but once.

But modern mass production and other economic factors have made science a dividend producer, even where it is not essential to make the product perform at all.

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POWER Stands for . .

1. Making Power When It Should Be Made
2. Buying Power When It Should Be Bought
3. Cheaper Power Through Modern Equipment
4. Easier Financing of Equipment Purchases
5. Better Use of Byproduct Heat and Power
6. Operating Methods That Save Money
7. Less Waste in Transmission and Application
8. Prevention of Smoke, Within Reason

Successful lubrication of machinery will not exist unless the effects of speed, temperature and pressure existing at the point of application have been anticipated

Effect of Speed, Temperature and Pressure Upon Lubrication

By ALLEN F. BREWER

IN THE operation of certain types of machinery speed will play an important part in the development and maintenance of a lubricating film. In plain bearings, for example, the higher the rotating speed of journals or shafting, the more readily will oil be drawn into the clearance spaces from the source of supply. In other words, under comparatively constant speeds, if the viscosity of the oil used is such as to follow the rotating shaft readily, effective lubrication can be depended upon. As a general rule, in plain-bearing operation lower operating speeds will require somewhat heavier-bodied oils than where speeds are comparatively high. Centrifugal force is normally a negligible factor in bearings of this type.

With ball or roller bearings, however, or gears, cams or chains, the effects of this force must be carefully considered. It is perfectly obvious that as such elements rotate there will be a tendency for the lubricant to be thrown off or away from the parts requiring lubrication, which in the case of ball or roller bearings would result in the formation of a layer of oil or grease on the inner surface of the raceway. No detrimental results would ensue, however, unless there was insufficient lubricant in the bearing to start with, in which event the rolling elements might not come into continual contact with the lubricant. An excess of lubricant, on the other hand, would be objectionable, inasmuch as churning would occur, leading to overheating and in the case of heavier greases resulting in unnecessary power consumption which would in part offset the advantages of such bearings.

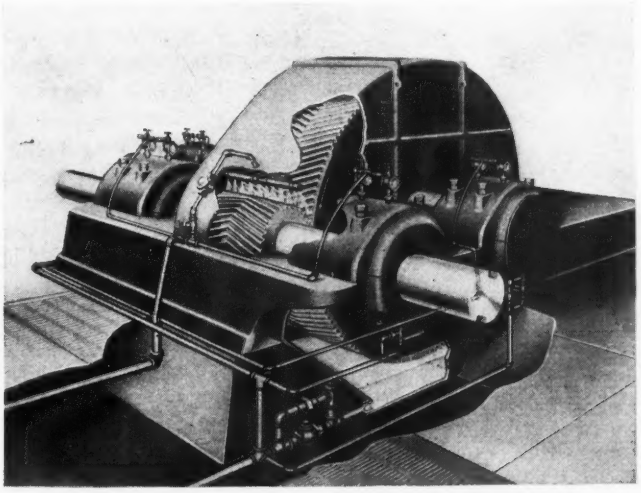

Fig. 1—A reducing gear requires an oil of special characteristics

Where gears, chains or cams are involved there is normally no retaining element in sufficiently close contact to prevent lubricant from being thrown from the teeth, links or cam surfaces under high-speed rotation. For this reason lubricants intended for such service should be of sufficient viscosity and adhesiveness to insure resistance to this action of centrifugal force. A wide viscosity range is required for such operations, dependent upon the design, means of application of the lubricant, peripheral speed and nature of the housing. Steam turbine reduction gears, for example, are tightly housed and normally pressure oiled; in consequence, a medium-viscosity oil will normally serve the purpose. Here volume and pressure compensate for body or viscosity and adhesiveness.

Exposed or non-tightly housed gears, on the other hand, require a much heavier gear lubricant. This same holds true for chains and cam surfaces. In effect, the purpose is to select a lubricant that can be depended upon to form and maintain a protective film on the wearing elements, with the least possibility of loss by throwing off, or excessive power consumption. This latter might easily develop were too heavy a product employed.

Pressure exerts a squeezing-out action upon a lubricating film, virtually regardless of the construction or design of the parts to be lubricated. Where pressures

may be at all high the specific characteristic in a lubricant that should be considered is body or viscosity. Size is not necessarily an influencing factor, but, in company with load, journal size should always be studied, for it involves weight. A set of properly designed gears, for example, may be very large, but if the transmitted load is low, the pressure exerted upon the tooth surfaces may not be abnormal. And yet, a small worm reduction set may be subjected to such a heavy duty as to render lubrication of the worm and gear teeth a difficult problem.

In machinery operations where pressure may prevail, the operating pressure is the important factor to be considered. Take a rolling mill or metal press, for example; when idling the pressure developed between the gear teeth or upon certain of the bearings may not be abnormal. Idling should therefore present no particular problem in maintenance of lubrication. In operation, the necessary pressure that must be exerted upon the raw materials in forming finished or semi-finished products will often react back through the moving elements of the entire machine. On some parts this will be more intense than on others, dependent upon their size or relative importance in design. Nevertheless, reactionary, or back, pressures of this nature will be considerably in excess of the idling pressures, and therefore a potential cause of lubricating difficulties, requiring careful study in the original selection of oils and greases.

In making such a study, one must bear in mind that it is essential to use lubricants that possess sufficient body and adhesive ability to resist being squeezed out from between gear teeth or chain-link connections or between bearings and shafting. The maximum pressure to be encountered should be considered in this regard. When idling, high pressures may result in abnormal internal friction within some types of lubricants on certain machinery. While this may be a detriment from the viewpoint of power consumption, it must be taken as a necessary evil, for it is far more important to prevent metal-to-metal contact and abnormal wear under high operating pressures than to reduce power consumption during idling, especially since the time spent in idling is relatively short.

Rolling or direct pressing is involved in the manufacture of many essentials today. Where rolling is involved materials may either be worked down from larger size, as in the rolling of steel, or pressure may be utilized to finish or imprint designs upon the product. Direct pressing, in turn, is largely employed in the formation of cans and in the manufacture of automotive parts.

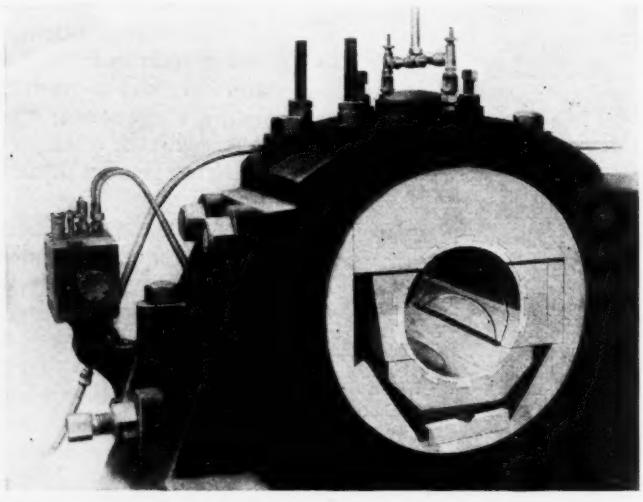

Fig. 2—An oil film must be maintained on engine bearings

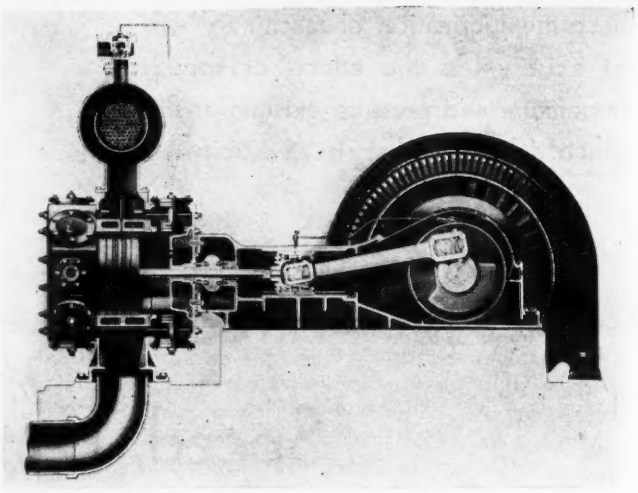

Fig. 3—In compressor cylinders the effect of temperature is a factor

Heat is often used along with rolling pressure. Examples of this are the textile calender roll and the dry end of the paper machine, where steam is circulated through hollow rolls equipped with cored-out journals or roll necks. As a result of this type of construction the bearings carrying these journals will receive more or less conducted heat from this steam, especially on the inlet side. Cooling-water coils may be provided. One must therefore consider this problem of heat, as well as the unit pressure on such bearings, when selecting lubricants, choosing products of proportionately high viscosity, or body.

With direct-pressure machinery, however, such as the meal press, hammer or stamping machine, operations are normally intermittent, motion being reciprocating and pressure exerted on the down stroke of the stamp or die. There is normally no heat applied in such operation.

The relation of temperature to lubrication is of importance by reason of the effect upon the viscosity of the lubricant. High-temperature conditions in particular will as a general rule impose as severe a requirement upon a lubricant as any other operating condition. The extent to which higher temperatures may be encountered will depend on the surrounding conditions as well as upon the degree to which solid friction is reduced by lubrication. Any two solid surfaces in motion with respect to one another implies the presence of heat, for friction cannot occur without the development of some heat. The purpose of lubrication is to reduce solid or metallic friction, supplementing it with fluid friction, which will normally lead to a temperature reduction. In this way a considerable reduction in the amount of power necessary to move the working elements with respect to each other will normally result.

The effect of temperature upon viscosity must be thoroughly understood. This property will vary inversely with temperature; the higher the latter, the more fluid will be the average lubricant. Where operating conditions can be controlled this is an asset, for it may enable one lubricant to be used for a number of points of varying external temperature, particularly where the size of the moving parts and the pressure exerted were studied before the original selection of the lubricant was made.

In event of variation in temperatures, however, change in the "operating viscosity," or the body of the lubricant under actual working conditions, may sometimes lead to serious impairment of lubrication. Where the lubricant

is too viscous, due to cold conditions, it will impose more or less drag, and result in added power consumption, as well as higher bearing temperatures, on account of internal friction. In turn, if the viscosity is too low, under high temperatures, maintenance of the lubricating film may be affected, permitting solid or metallic friction and resultant wear; the power bill may also suffer. It is obvious that there is a direct tie-up between power consumption, friction and temperature.

High-temperature lubrication will frequently lead to objectionable carbonaceous deposits. The extent of such deposits will depend upon the degree of heat present, refinement of the lubricant and the source of the original crude oil. There are some types of crude from which distillates can be refined that will show an almost negligible amount of carbon residue. Cylinder stocks, which are residual oils, may have a very high carbon residue content. Here again the extent of refinement will also be a factor.

The type of service to which the lubricant is to be applied will be the criterion as to whether carbon will be an ultimate detriment. In air-compressor operation carbonaceous deposits on cylinder or valve surfaces, due to abnormal vaporazition of an oil under higher temperatures, might lead to serious results. On the other hand, a set of exposed gears adjacent to a cement kiln will function effectively irrespective of the carbon content of the lubricant.

It is not enough to confine a study of the effect of temperature upon lubrication to viscosity and carbon detriments. The flash and fire points of oils must also be considered where certain phases of high-temperature lubrication are involved. This will be especially true where lubricants are more or less directly exposed to flame or to steam- or electric-heating mediums, as would occur in the lubrication of open-hearth charging cranes, steam engines operating on superheated steam, baking ovens, steel treating furnaces, or textile finishing machines.

Direct exposure of lubricants to heat may permit more or less rapid vaporization of the more volatile constituents. If this continues for any length of time the oil will become heavier and heavier until there will be an accumulation of non-lubricating carbon residues. Continued exposure of these latter to heat will cause them to bake or coke into a hard mass which might easily clog the oil grooves of bearings or the circulating-oil piping. Under such conditions of operation lubricants should always be selected for their ability to resist these objectionable effects of high temperature. The flash and fire points will be indicative of this ability.

It is important to remember, however, that flash and fire point readings for any oil are of value only as indicators of the relative initial volatility. They do not indicate lubricating ability. They should not be regarded as definite temperatures at which boiling takes place, or at which an oil may pass completely over to the vapor stage; the make-up of the oil itself will influence this. On the other hand, there is a relationship between flash and fire points and viscosity. Oils of higher flash and fire points will in general be of higher viscosity, especially if their hydrocarbon composition is similar.

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Test Boiler Arranged for 400-Lb. or 150-Lb.

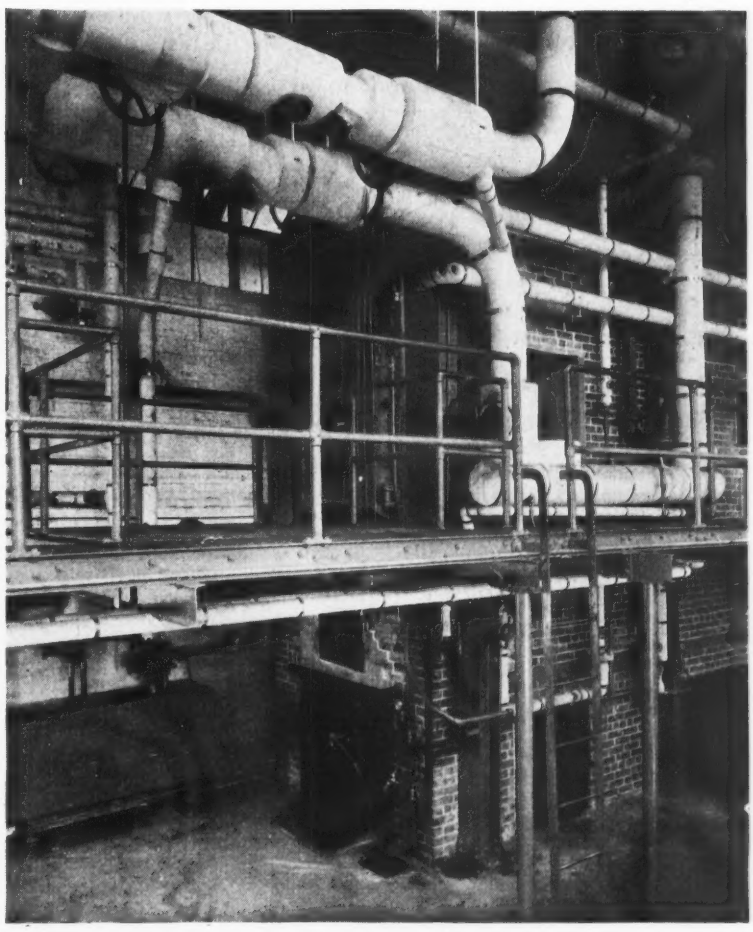
A BOILER installation recently made at the plant of the Mason Regulator Company, Boston, Mass., operates at both 150 lb. and 400 lb. pressure. Normal operation is at 150 lb.; the higher pressure is carried when needed for the testing of regulators manufactured by this company.

The boiler is a 930-sq.ft. sectional water-tube oil-fired unit. To provide for sharp variations in load, the burner is automatically controlled by a diaphragm-operated mercury switch which, in turn, controls the operation of a motor on the oil feed valves.

The unit is provided with two headers, one for 400 lb. pressure and the other for 150 lb. The former leads directly to the high-pressure test stands and is also connected through a reducing valve to the 150-lb. system.

During normal operation, when no 400-lb. steam is required, steam is supplied directly from the 150-lb. main for general process work, oil preheating, etc. Further provision is also made for steam reduced to 30 lb. and heating pressure.

The 400-lb. steam is available at controllable superheats up to 300 deg. so that all regulators may be tested under service conditions.



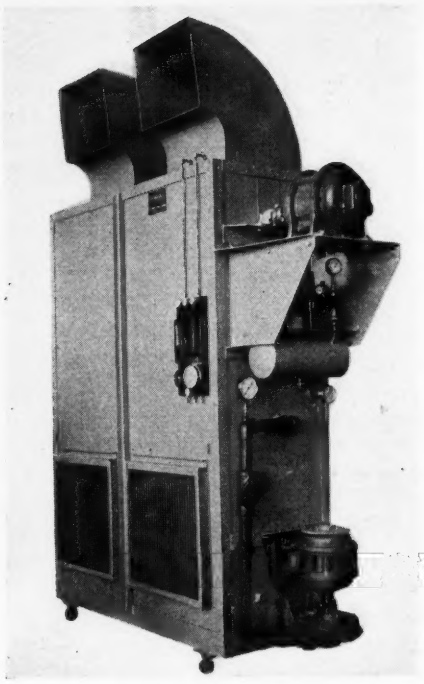


Fig. 1—An air conditioning unit complete with water spray, humidity control and fan

Mechanical or Ice Refrigeration for Air Conditioning?

By LEON BUEHLER, JR.,
Frick Company, Inc.
Waynesboro, Pa.

While the maintenance of a comfortable room temperature has been an actuality for years, only recently has man learned to produce really comfortable conditions in summer. It must be admitted, however, that even at the present time the process is so costly as to be economically possible only in places where crowds congregate or in the homes of the wealthy. It is a challenge to the engineer and to business to make the benefits of air conditioning possible to greater numbers. The demand exists. Some economists even prophesy that this infant industry will lead the way out of the depression

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COMFORT depends upon a large number of variable factors. Air temperature, humidity, air velocity, temperature drop that can be evidenced without chilliness, clothing worn, activity of the occupants, mental state, such as excitement or meditation, and a personal factor varying with individuals, all combine in fixing the degree of comfort. The old notion that 70 deg. F. is the ideal has been exploded.

To produce the correct air condition in summer it is necessary usually to condense some moisture out of the air as well as to reduce its temperature, for the 80 deg. outside atmosphere contains so much moisture that when this air is cooled to 70 deg. F. or lower the humidity is too high. Simply cooling to the desired temperature results in a very humid atmosphere, so that the cooling must progress to a still lower temperature in order to condense some of the water vapor, followed by reheating to the desired room temperature. The simplest air-conditioning method, then, consists of passing the air through a cold water spray, where it is saturated with moisture, and then heating it to the desired temperature. To save in refrigeration most of the room air is recirculated, with just enough outside air added for ventilation. This method still requires too much refrigeration. Frequently only a part of the recirculated air passes through the cooler, and the balance mixes with the cooled air, which eliminates the reheating.

By another method all of the air is passed through the coolers, where the air is chilled only to the desired temperature, the humidity being controlled by the character of the spray. In simpler plants the air is simply chilled by cold surfaces similar to the familiar unit heaters, which are radiating surfaces set in front of fans. The refrigerant may be any one of the familiar chemicals or preferably cold water.

Many of these plants use cold water for cooling, but where a supply of water cold enough for the purpose is not available it is the practice to cool water by mechanical refrigeration. True, some crude attempts were made to

cool with ice, such as by blowing air over cakes of ice set in a tank. The inevitable failure seemed to show ice unsuited for this purpose until within the past year, when ice was melted in water and the cold water was sprayed into the air. This replaces the mechanical refrigeration system but leaves the balance of the air-conditioning equipment unchanged.

The ice industry recognizes this development as a huge potential outlet for ice and has entered into an ambitious educational and publicity campaign. Its spokesmen quite naturally are enthusiastic in their claims. The author is employed by a company manufacturing refrigeration machinery used in ice-making as well as in air-conditioning plants, so that he is equally interested in comfort cooling whether by ice or mechanical means. He can therefore take an unbiased view of the merits of the two systems.

Water temperatures around 50 deg. F. are required for air conditioning. As ice is at 32 deg. there is no question that it is possible to cool the spray water. As a matter of fact, several theaters, restaurants, drug stores, offices, and even railroad coaches, have been cooled with ice.

Considering thermal efficiency, ice is decidedly wasteful. In the manufacture of ice, relatively warm water must be chilled to 32 deg. F. before it can be frozen. The refrigerating equipment must remove from 200 to 230 B.t.u., while the ice will take up only 182 B.t.u. per pound in melting and rising in temperature to 50 deg. F. Furthermore, in the mechanical plant the evaporator can operate at around 30 to 40 deg. F., while in the ice plant the ammonia in the evaporator coils in the ice tank operates at from 5 to 10 deg. F. As a compensating factor the ice plant with its high load factor is likely to enjoy a lower power cost per ton of refrigerating effect.

Economics is the deciding factor. Probably ice will always cost more than the direct operating costs of the mechanical system. Under this item are included power, water, oil, refrigerants, other supplies, operating labor and maintenance. Possibly in the very small conditioning plants in cities where a local ordinance requires a licensed operator the ice would not be more expensive. On the other hand, the first cost of the mechanical plant is considerably higher than the ice unit. Interest, taxes, insurance, depreciation must all be charged on this higher investment. It depends entirely upon the hours of operation per year as to how seriously overhead affects the cost of refrigeration. This depends upon the application and climatic conditions. For instance, an air-conditioned factory in the tropics operating on a 24-hr. day basis would have an unusually high load factor and ice could not possible compete with the mechanical plant. As the other extreme, a convention hall in the North used three hours in the evening for three nights a week, where air cooling is needed for not over four months a year and not even on every day in that period, would have such a poor load factor that ice would be much cheaper. Most plants will fall between these extremes. The first cost of plants of different sizes and types varies so greatly that each one must be analyzed on its own merits.

The ice installation has a high overload capacity. The heat absorbed depends upon the rate of ice meltage, which can be controlled between wide limits at will. A plant using 10 tons of ice in a day may consume perhaps 3 tons in a single hour. In this case a mechanical plant to give the same result would require a capacity of 3 tons per hour, or 72 tons per day, rather than 10 tons. Of course, the mechanical plant may be provided with large cold-water storage tanks to take care of periods of peak load, but cost and space limit this water storage.

The mechanical plant takes considerably more space

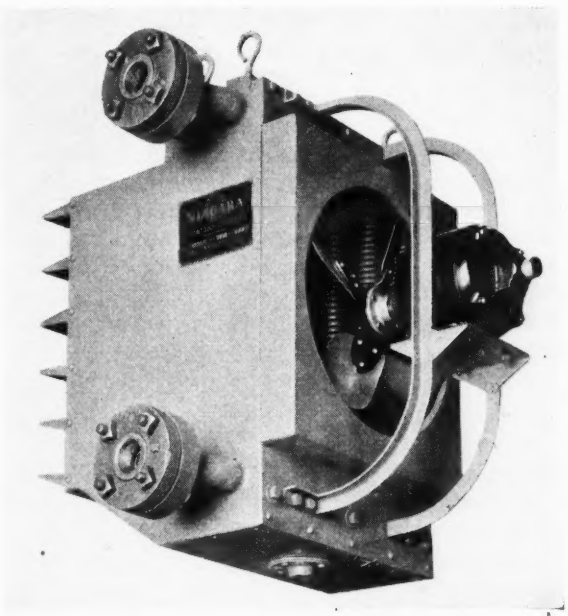

Fig. 2—A type of unit air cooler in which either cold water or an evaporating refrigerant may be used

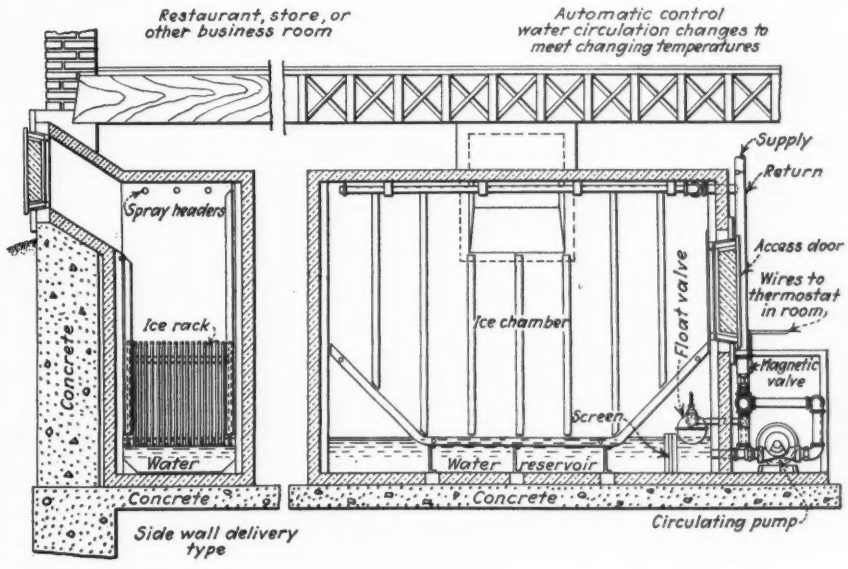

Fig. 3—Ice Melting Chamber used in connection with unit coolers such as shown in Fig. 2

than does the ice plant, which frequently is of great importance. The melting of ice is noiseless, but the mechanical plant may cause undesirable vibration and noise. De-icing could be done quietly or at times when noise is least objectionable.

Many refrigerants are toxic or highly irritating, hence potentially dangerous. As a matter of fact, such refrigerants should be used for this class of work only when provided with all of the safeguards specified in the safety code of the American Society of Refrigerating Engineers, or, better yet, a harmless refrigerant like carbon dioxide could be employed. Ice, of course, is entirely harmless and odorless.

Mechanical Refrigeration Plant Requires Much Water for Condensing

The mechanical plant needs much water for condensing. Where the water is costly or where it is impossible to dispose of the used water, a cooling tower or spray pond must be employed. On many buildings it is difficult to provide for a cooling tower. In addition, as a cooling tower transfers the condensing heat to the surrounding atmosphere resulting in a high humidity, it may prove objectionable to neighboring properties and in congested districts where a number of cooling towers might be operating close together their use may be entirely prohibited. The iced plant requires no water at the building being air-conditioned.

Ice undoubtedly has possibilities in this field and the results to date should not be taken as final. Perhaps cracked ice, "Packice" or "Flakice" will prove to be better in that the air may be blown directly over the ice. The ice, however, must sell for considerably less than retail prices to warrant consideration. This should not be an obstacle, for unsalable pieces can be used, such as cracked or white ice. The peak of the air-conditioning load coincides with the peak demand for ice for other purposes so that extra plant capacity must be provided for this market. In the long run this new business must, therefore, stand on its own feet to be profitable. The author feels that air conditioning in general will be stimulated by the entrance of the ice industry into the field and that many plants will use ice. However the ice man must fight for his share of the trade, as the mechanical plant can by no means be considered obsolete.

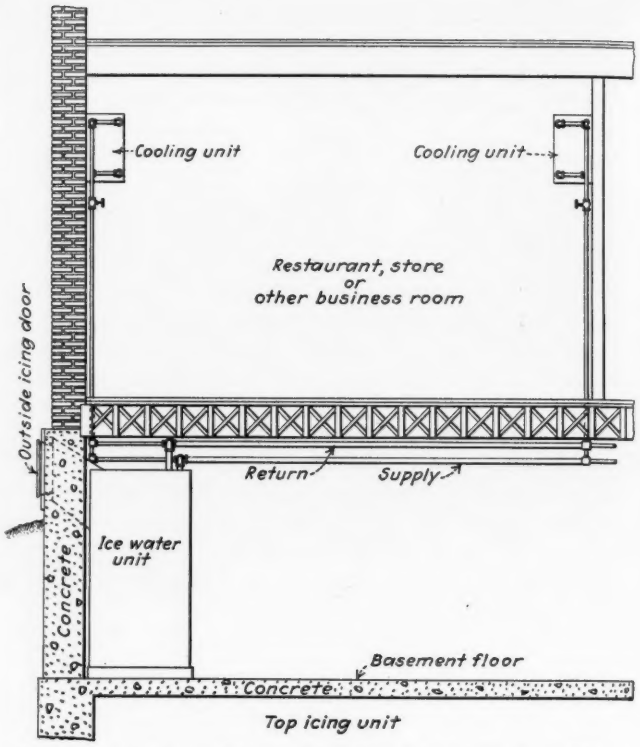

Fig. 4—An ice melting unit employed in connection with unit coolers

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Low Voltage Caused Induction Motors to Heat

By CHARLES A. ARMSTRONG

ON ALTERNATING-CURRENT motors, if trouble is being experienced that is not easily accounted for, a voltage test is in order. Since the torque of induction motors varies as the square of the voltage, they are very sensitive to voltage changes. A 40-hp. 440-volt 1,750-r.p.m. induction motor driving a centrifugal pump gave trouble by overheating and operating at reduced speed. An examination of the motor revealed nothing wrong except that the air gap around the rotor was unequal. This was corrected by replacing the bearings, but it did not eliminate the trouble.

A voltmeter test showed that the voltage at the motor terminals when driving the load was 370 volts. Under this condition the motor's torque was only $(370\times370)\div(440\times440)=0.71$, or 71 per cent of what it would be at normal voltage. As a result the motor slowed down to allow a large increase in current to flow in the windings to produce the necessary torque to drive the load. The trouble was found to be caused by an overloaded feeder and transformers. Correcting these faults eliminated the motor trouble.

Where regular voltage and load surveys are not made, feeders and transformers are likely to become overloaded due to machines being added occasionally to the lines without anyone considering what effect these increases in load may have. Probably to start with the lines have little or no excess capacity for the load and any additional that may be connected at a later date is likely to cause trouble because of excessive voltage drop.

Induction motors are generally designed to operate with a 10 per cent reduction in voltage below normal. However, if a motor happens to be fully loaded or slightly overloaded, a 10 per cent voltage drop may give trouble, due to heating. After a motor has been in operation its ventilating system is not as effective as when it was new, on account of dust and dirt getting on the surfaces from which the heat must be dissipated and because of air ducts being partly or entirely closed. If the effects of a 10 per cent voltage reduction are added to those of an impaired ventilating system the results may be an excessively hot motor. This combination of conditions is probably the cause of motor winding failures more frequently than is generally appreciated by operating engineers.

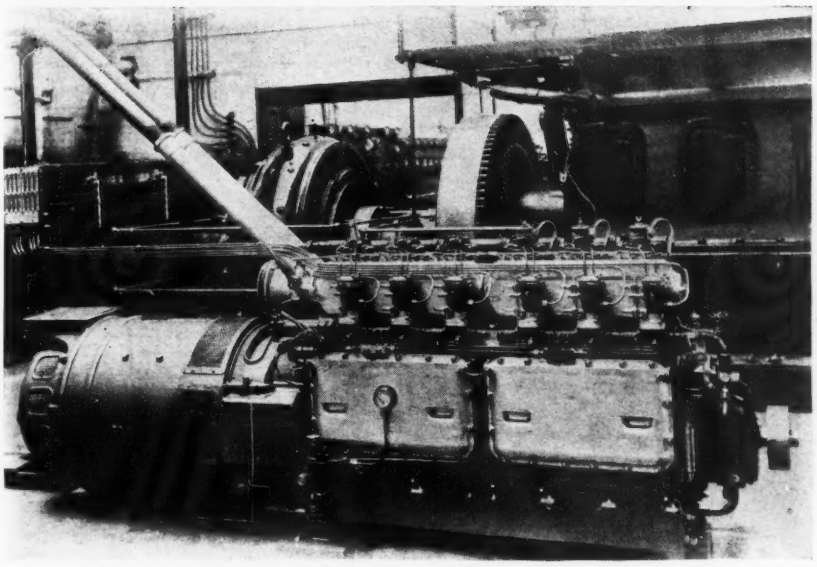


Fig. 1—A 120 hp. 1,200 r.p.m. Mirrlees-Recardo diesel installed alongside a slow-speed unit

Trends in Diesel Engines For Industrial Power

By OLIVER F. ALLEN

Consulting Engineer

It has been pointed out in previous articles of this series that the diesel engine of today is suitable for central stations, for locomotives, for road vehicles and for a variety of auxiliary service. These involve a wide range, from the heavy slow-speed diesel, associated with their permanent installation, to the light-weight high-speed machine requiring little or no foundation, which is mobile as to its location and installation

THERE is a very marked change in attitude by engine manufacturers and users as to the type of diesel best suited for industrial power purposes. In place of the slow-speed heavy diesel, which as to location of necessity had to be restricted to the power house, present-day trends are toward high speed engines placed in the factory close to the points of application of the power, giving all the economy of diesel power and the flexibility of the electric motor.

For the smaller industrial and isolated plants the comments on automatic control features in the article "The Diesel as an Auxiliary to Central Power Systems" in *Power*, Nov. 10, 1931 and the advantages of high speed, light weight engines, stressed in "Diesel Engines as Portable Power Plants" in the Jan. 19, 1932 number, are as pertinent when considered for permanent and independent installations as when thought of for auxiliary or temporary services. It is no more necessary to have starting difficulties, control limitations, irregular or unreliable performance with a small diesel plant than it is with a modern, standard light delivery truck. Both have been greatly improved during the past few years.

Just as the old, garden variety of hand fired, horizontal tubular boiler and slide-valve steam engine still exist, the heavy, slow speed oil engine still meets some conditions. But, even as water tube boilers, automatic stokers, uniflow and corliss valve reciprocating engines and steam turbines have greatly increased the practicability and efficiency of relatively small steam plants, there are tendencies which are promising much for the further improvement of the smaller oil engine installations.

Not only have higher speeds and lighter weight come into existence, but greatly improved lubrication, and in many cases anti-friction bearings, light weight pistons and connecting rods, honed cylinders, improved valves, quiet operation and easy starting are now common.

The four-cycle industrial diesel has, in general, followed the same lines of development as gasoline truck and bus engines and, while admitting greater weight per horsepower, to insure longer life, the purchaser of a diesel for industrial or isolated plant today is justified in demanding most of the good features of the best automotive engines.

In some respects the industrial diesel has already advanced beyond the gasoline engine. We have accepted the poppet valve, four-cycle engine as the American standard in our automobiles for several years, and have almost forgotten that there may be some other arrangements better suited to many conditions. The Knight sleeve valves were much talked about a few years ago, but, under our manufacturing conditions and with our standard tolerances, the Knight engine costs in the order of 20 per cent more to manufacture than a poppet valve engine of the same rating, and tends to require more lubricant. The situation in Europe has been somewhat different and relatively more sleeve valve engines are being put into automobiles over there. The advantages of sleeve valves may cause an evolution in diesel valve design. Just as the old cornish valve, after it was ceremoniously buried in the steam field has come to life in the improved forms used in present day reciprocating steam engines, some of the features of earlier internal combustion engines, not practicable when first developed, are now reappearing, modified to meet present needs and manufacturing facilities. There are sev-

eral recent examples of the application of sleeve valves, but only the most outstanding one will be discussed, as indicative of several developments here and abroad.

After years of research and experience with internal combustion engines in Great Britain, Ricardo developed a single sleeve which, by means of a crank on the half-speed shaft, combined with a ball-and-socket joint at the end of a forged steel beam, is given a combined reciprocating and turning motion, so as to give rapid opening and closing of both air admission and exhaust ports.

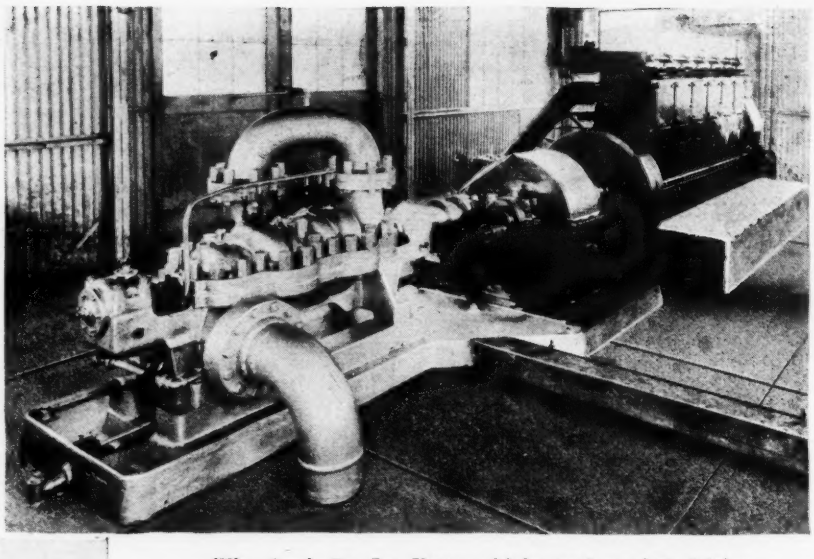


Fig. 2—A De La Vergne high-speed engine driving a centrifugal oil pipe line pump

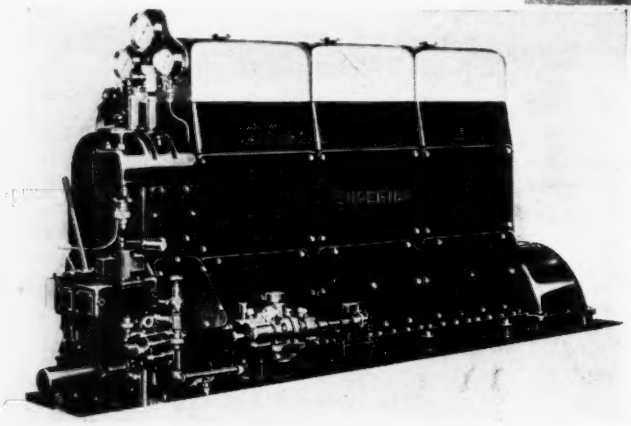


Fig. 3—A high-speed unit designed for industrial purposes

This plain, cylindrical, centrifugally cast-iron sleeve takes the wear of piston and piston rings and is easier and cheaper to renew than a cylinder or liner. The absence of admission and exhaust valves in the cylinder head allows of a very simple and robust design. Engines of this type are being built for industrial service by two leading British manufacturers and it is understood that they will soon be in production in England for aircraft and in the United States for various services.

The hot-bulb has pretty generally disappeared and cold starting is almost universal. The combustion chamber, however, appears in many shapes and types, including precombustion chambers, antichambers, modified hot-bulbs inside, and auxiliary compression chambers such as is used on Lang's new engine, to say nothing of pancake, cylindrical, spherical, pear-shaped, and doughnut shaped combustion chambers. It is a period of evolution, but the trend is certainly towards the simplest possible combustion space, combined with turbulance and good scavenging. These are only possible with high volumetric efficiency. This may ultimately mean the more general utilization of supercharging, which, at the present time, for industrial installations at ordinary altitudes is hardly commercial. For high altitudes, say, 7,500 ft. and over, supercharging is both practical and economical for isolated plants of all types.

We are hearing more and more of the small two-cycle engine, which has not only shed its hot-bulb, but also, with few exceptions, abandoned the objectionable crank case compression. There are a few good, efficient two-cycle engines still made with that type of scavenging air blast, which are also economical of lubricating oil, but they are so exceptional, and confined to such small sizes, that they are less and less a factor in the market.

Generally speaking, two-cycle engines are now universally cold starting, with reciprocating, rotary or centrifugal scavenging air blowers and solid fuel injection. All three types of blowers are used successfully on good engines.

Ports in the cylinder, and in the liner when the latter is used, controlled by the movement of the piston may perhaps be called standard practice, but both poppet and sleeve valves in the head, combined with ports in the cylinder walls, are also employed by first class manufacturers. Usually the valves in the head are for air admission and the ports for exhaust, but sometimes it is the other way about. High-speed internal combustion engines of all types have

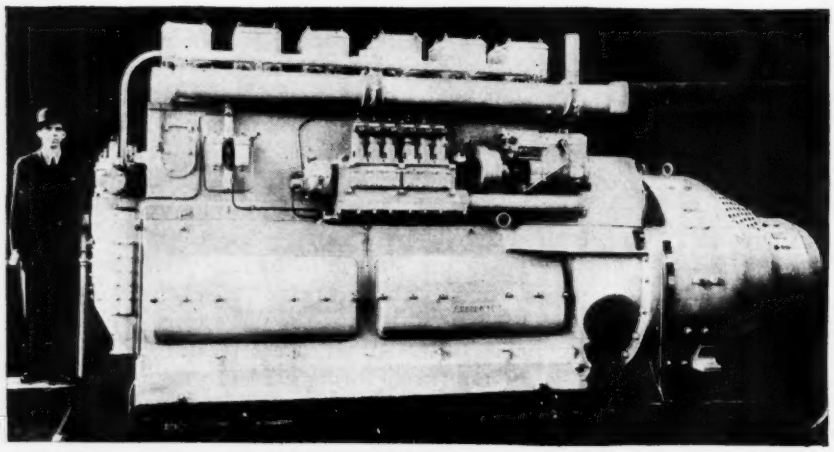


Fig. 4—A McIntosh & Seymour diesel designed for locomotives but suitable for industrial power

tended to "knock," to be noisy and to have poor combustion under some operating conditions. Various makeshifts, including "anti-knock" fuels have been tried, but improved design is the only true solution. Improved combined filters and silencers on the air intake have done much to solve the noise problem, and should always be required in industrial installations, for the protection of the engine itself. In the case of industrial units such as are now being considered, neither "knock" nor poor combustion need be feared in first-class engines.

There is an ever-present desire for improvement, and one of the things which many research workers are now trying to accomplish is smoother, less explosive, burning of the fuel charge combined with higher brake mean effective pressure. In other words, constant pressure burning, such as Dr. Diesel aimed at, with a "fatter" indicator diagram, more like a steam engine diagram.

In the article "Diesels in the Air" in the Feb. 16, 1932 number of *Power,* the Junkers opposed-piston, two-cycle engine was shown. Broadly speaking, that is typical of the Doxford, the Fullagar and other engines built for land service. The Junkers is built for industrial and other automotive applications besides air service. In some types the stroke of the two opposed pistons is different and the cranks are set so that one piston leads the other by a few degrees. These features change the compression and expansion cycles and the time of firing.

In this country, Martin, and more recently others, have sought the same end by introducing a displacement sleeve, surrounding the piston, and timed to retard the point of minimum volume until after the main piston has passed dead center, and to control subsequent combustion chamber volume to improve the turning moment diagram during the expansion stroke, with increased brake mean effective pressure, greater output, and smoother operation. In the four-cycle design the sleeve serves only this purpose of changing the diagram from that of the conventional engine, the normal inlet and exhaust valves being retained. In the two-cycle engine, the sleeve also combines with the piston and the cylinder ports to control admission and exhaust.

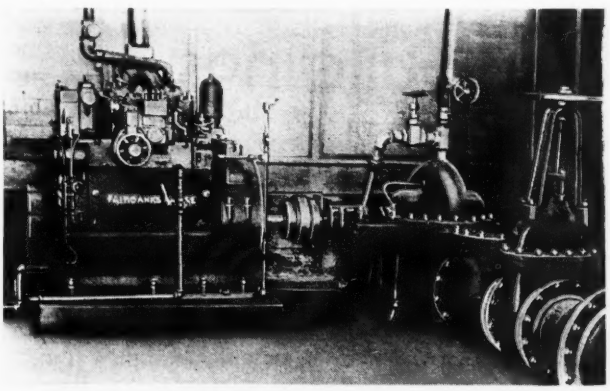


Fig. 5—High-speed diesel driving water pump

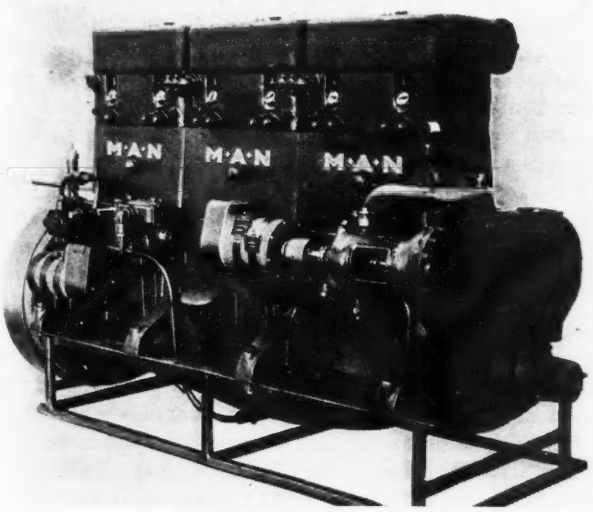


Fig. 6—A portable German unit

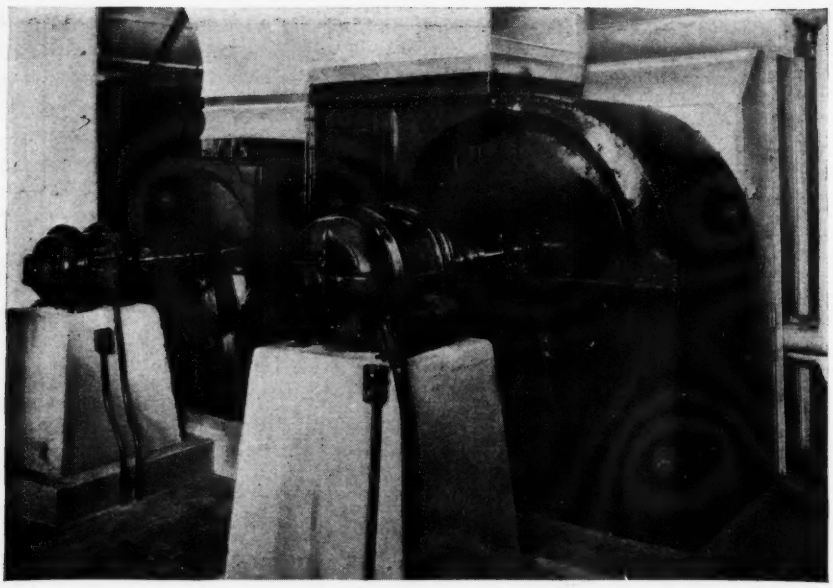
The Objective of Design Is Smooth, Quiet and Efficient Operation

To summarize this situation, taking Knight, Junkers and Ricardo as typical; Knight has two sleeves, functioning only as valves, with the conventional compression-combustion cycle; Junkers has two pistons, functioning as valves and sometimes arranged to depart from the normal compression-combustion cycle; Ricardo has only one sleeve, which functions as valves in such a way as to create, in combination with his combustion chamber, great turbulance, while retaining the conventional cycle; Martin modifies the conventional cycle, and in his two-cycle type, uses the sleeve for this purpose and also as valves. Others are using variations of these types, including an auxiliary cylinder with a piston in place of the displacement sleeve.

These efforts all point toward making the operation of diesels smoother and quieter, as well as even more efficient. Again we see the effort to equal the performance of the electric motor, while providing a prime mover which does not have to have a wire tied to it.

These variations and tendancies in design have been indicated at some length in order to call attention to the fact that there are many types of first class oil engines available, just as there are of passenger automobiles or suits of clothes. The purchaser must recognize the necessity of intelligent selection and the importance of dealing with responsible, experienced and progressive manufacturers. The oil engine is here as a simple, compact and efficient machine for industrial and other isolated plants. When economically justified, it can be provided with remote hand control, semi-automatic or full-automatic control, and through existing, well-tried means, can be well protected against accidents. In fact, some of the protective devices used in connection with automatic control are more sensitive in detecting such things as overheating, clogging and sticking than the best engineer can be.

In conclusion, a word of warning about fuels may save some grief. Very large diesels are designed to use the heavier, dirty oils where availability and relative cost make it economically desirable. But for the ordinary small and medium sized plant in this country, the modern good diesel is so efficient, and the fuel so cheap, that with ordinary load and utility factors in such plants, the difference in cost between good clean fuel and dirty fuel does not represent any appreciable saving in over-all power cost, especially when maintenance over several years and losses due to interruptions of service are considered. The present day diesel will do wonders in industrial service, but give it good fuel, the best lubricant, plenty of cooling water, and keep the engine itself free from dirt.



Squirrel-cage motors drive ventilating fans in a large office building

Alternating Current Motors for Ventilating Fans in Buildings

By J. A. JACKSON

Industrial Engineering Dept.
General Electric Company

The 50 per cent speed range generally specified for direct-current motors driving ventilating fans is considered excessive for most installations. Since alternating-current motors do not lend themselves as readily to speed adjustment, a careful check should be made on the speed change required and this kept as small as possible. Methods for doing this are suggested

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UNTIL quite recently it was considered necessary to use direct-current motors for driving ventilating fans in buildings in order to secure the satisfactory speed adjustment that can be efficiently obtained by shunt-field control on a suitable designed direct-current motor. The practice of engineers has been to specify that motors should give a speed adjustment from maximum fan speed to 50 per cent of that speed. There is doubt, however, if such a large range is necessary in most cases. Where such a range was provided the lowest speed was the full-field speed of the motor.

Just why so large a speed adjustment was selected is not quite clear. Perhaps the fact that direct-current motors could readily be obtained which would give this range had more weight than whether the range was actually necessary from the standpoint of ventilation. A direct-current motor operates at high efficiency over such a speed range and the speed is stable over this range regardless of load changes, on account of the inherent characteristics of these motors. In contrast to this, alternating-current wound-rotor induction motors are neither efficient nor stable in speed when operating over a large speed range, particularly with a fan load.

Power supply in most cities is now alternating-current. On account of the objection to conversion equipment alternating-current motors are coming into more general use for driving fans. The direct-current practice of using a slow-speed motor directly connected to the fan is having to be abandoned, because alternating-current

motors in the desired capacities have undesirable characteristics when designed for slow speeds. Alternating-current motors of 900 and 1,200 r.p.m. are now commonly used, requiring a speed reducer between motor and fan. Multiple V-belt drives are preferable, as they are quiet, permit short pulley centers, save floor space, have reasonably long life, low initial belt tension and are efficient. The pulley ratio does not have to be very large, as the fan manufacturers have helped the situation by a design with blades curved against rotation which operates with equal efficiency and quietness at about twice the speed at which the sirocco-type fan operates.

Where constant-speed fans meet all ventilating requirements a squirrel-cage motor is used. This type of motor holds constant speed within 2 or 3 per cent regardless of load, but there is no way conveniently and efficiently to vary its speed by the control equipment. If, therefore, the air-duct characteristics are not definitely known and it is found after installation that more air pressure is required, the only recourse is to change the pulley ratio. This increases the power demand from the motor as the cube of the fan's speed; if a situation of this kind is likely to arise the motor should be selected with an ample power margin to permit a pulley change without overloading.

Wound-Rotor Type Motor

Where an adjustable fan speed is necessary to meet the ventilation demands, a wound-rotor type motor is selected. While not as flexible and efficient as a direct-current adjustable-speed motor, it is the best alternating-current variable-speed motor obtainable when other necessary characteristics are considered. It has a very definite top speed, the rated full-load speed, which cannot be exceeded by the use of any form of control equipment. The rated full-load speed can only be obtained with rated frequency and voltage applied and with the collector rings short circuited at the brushes on the motor.

Since the control is seldom mounted directly at the motor, but is often mounted on the opposite side of the room, the resistance of the wiring between the motor's slip rings and the control, and also the contact resistance of the control equipment, is permanently in the rotor circuit. This reduces the speed below the rated full-load value given by the motor manufacturer. Further, power companies seldom guarantee better than plus or minus 3 per cent voltage variation at the service entrance to the building and there is always an additional voltage drop between the motor and the service outlet which may amount to 5 per cent or even more. This voltage reduction still further reduces the motor speed below the rated full-load speed.

Fig. 1 shows the relation between slip of an induction motor and load output for a 10 per cent increase and a 10 per cent decrease in voltage applied at the motor terminals. A 1 per cent change in slip as read on the curve means a 1 per cent change in speed and vice versa. For these reasons, a speed of from 5 to 10 per cent below rated full-load speed should be used when selecting pulley sizes to give rated fan capacity and pressure. If the duct characteristic is not known within reasonable accuracy the larger percentage below full-load speed should be allowed. This will permit a larger increase in speed by rheostat adjustment if more capacity and pressure are desired. Obviously, the rated horsepower of the motor should be large enough to take care of the extra power requirements if the higher speed and pressure are used, remembering that the horsepower goes up as the cube of the speed.

Looking at this problem from a somewhat different viewpoint, a ventilating engineer may know that when he selects a certain fan for a given duty the entire rated

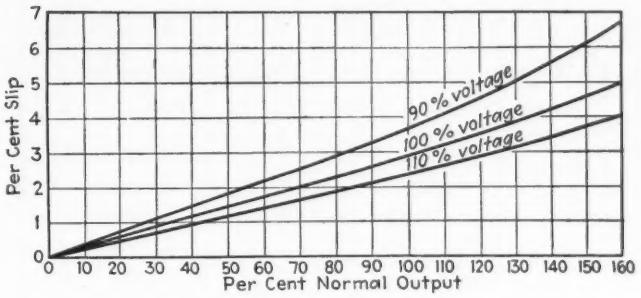

Fig. 1—Relation between slip of an induction motor and load output at different voltages

output of that fan will be required. In such cases a motor to give the horsepower output corresponding to the rated fan capacity may be selected. If the pulley diameters are calculated from the manufacturers listed full-load motor speed and the rated fan speed and, for reasons previously mentioned the motor runs below its rated speed, the fan speed will be low. This will reduce its capacity and the motor will not be delivering its rated output. A remedy for this is to change pulleys to obtain correct fan speed, but it would be simpler to have selected the pulley sizes in the first place from a motor speed 5 per cent to 10 per cent less than listed full-load speed. Then if an ammeter reading shows that the motor is not operating at its rating, the resistance in the slip-ring circuit can be adjusted to raise or lower the speed until rated output is delivered to the fan.

If this method of figuring pulley size is used, a secondary resistor should be ordered with the necessary capacity and fine steps of adjustment in that section of the resistor which may remain permanently in the circuit after the initial adjustment has been made to get full fan capacity. It should also be remembered that this scheme will reduce the over-all electrical efficiency by the loss in the resistor which is left permanently in the circuit. For this reason it is well not to pick too low a motor speed from which to figure the pulley size for rated fan speed.

As to the total desired speed range, a 50 per cent total variation can be obtained from a slip-ring motor, but not as efficiently as from a direct-current motor. Also, the alternating-current motor becomes quite unstable in speed with charges in load when operating at 50 per cent of rated full-load speed. The table shows the efficiency and speed stability for a slip-ring motor when operating at full-load, 85, 75 and 50 per cent speed with a typical fan load. Full-load speed is taken as 5

EFFECTS OF A 15, 25, AND 50 PER CENT SPEED REDUCTION ON A SLIP-RING MOTOR DRIVING A FAN

[1]Motor Speed, Per Cent	[2]Motor Horsepower Delivered to Fan, Per Cent	Motor Efficiency Per Cent	Speed Variation for 10 Per Cent Load Change, Per Cent	Air Pressure at Fan, Per Cent
100.0	100.0	85.0	0.8	100.0
85.0	61.4	75.0	3.9	72.0
75.0	42.0	66.2	7.3	56.0
50.0	12.5	41.5	46.0	25.0

[1]In the first column 100 per cent is taken as 5 per cent less than the manufacturer's rated full-load motor speed.

[2]In the second column 100 per cent horsepower is 86 per cent of the continuous rated motor horsepower as given in the manufacturers' commercial literature. This reduction to 86 per cent is necessary as the speed is reduced 5 per cent and the horsepower comes down as the cube of the speed, $0.95^3 = 0.86$.

per cent below the rated full-load speed of the motor. From the table it will be seen that if a total variation of 25 per cent by secondary resistance control is used, from 100 down to 75 per cent speed, the motor efficiency will be 66.2 per cent at the lowest speed. The motor's speed change for a 10 per cent load change will be only 7.3 per cent.

If a 50 per cent total speed variation is used, the motor efficiency at the lowest speed will be only 41.5 per cent and the speed change for a 10 per cent load change will be 46 per cent. Thus, not only does power consumption per cubic foot of delivered air become quite high, but the flow of air is likely to vary widely due to

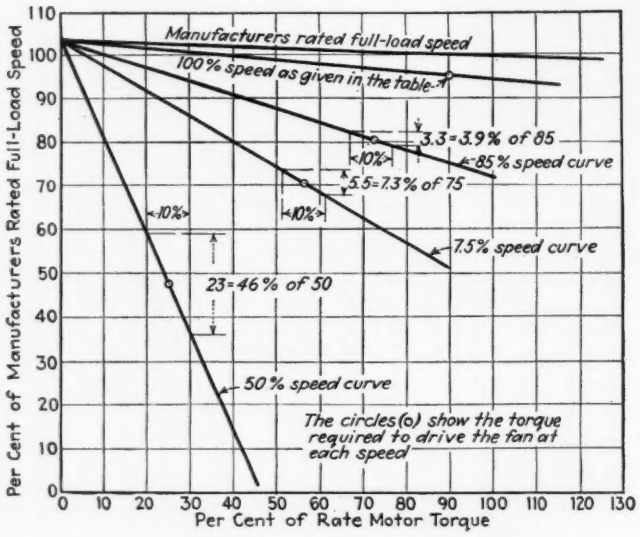
Per Cent of Manufacturers Rated Full-Load Speed
Per Cent of Rate Motor Torque
Manufacturers rated full-load speed
100% speed as given in the table
3.3=3.9% of 85
85% speed curve
10%
5.5=7.3% of 75
75% speed curve
23=46% of 50
50% speed curve
The circles (o) show the torque required to drive the fan at each speed

Fig. 2—Speed-torque curves of a slip-ring motor showing speed stability when driving a fan at 100, 85, 75 and 50 per cent speed

speed instability. The speed-torque curves, Fig. 2, show graphically the increasing instability as the speed is reduced. If a minimum speed of 75 per cent of the rated full-load motor speed is selected, power consumption per cubic foot of delivered air is much lower than at 50 per cent speed and the air flow is quite uniform, as the motor speed is fairly stable. Ventilation requirements should therefore be carefully considered and no greater speed reduction than is absolutely necessary should be called for when alternating-current motors are used. It is believed that a total reduction of 25 per cent in speed will fulfill the requirements in the majority of cases.

Even with the quietest motors that can be purchased it is always advisable to install them on good sound-insulating bases. The magnetic hum, while often inaudible to one standing by the motor, may be transmitted through the building steel work and magnified at some other place by the sounding-board effect of the walls, ceiling or floor. All motor manufacturers are reducing this magnetic hum to a minimum, but as long as alternating current is used there must be a rapid flux reversal in the motor, the frequency of which is such that a small amount of noise will be produced. Most manufacturers list lines of quiet motors especially for the building industry and while they are as quiet as it is commercially practicable to build them, sound-insulated foundations should always be used with them.

Specifying Steam Generating Units

By H. G. LYKKEN

BUYING a steam generating unit is more than buying so many square feet of tubes and drums, and some means of burning the fuel. These elements may be individually and adequately guaranteed but the construction of a furnace without proper consideration for the needs of the first two may largely nullify the expected operation of the unit.

In the old specifications, anyone's boiler, wide or narrow, and in any and every possible shape and disposition of heating surface, might be purchased with no responsibility, except as to outlet gas temperature. Some stoking equipment was then purchased to burn the necessary amount of fuel with competitive and meaningless guarantees as to over-all efficiency placed on the stoker manufacturer when the all-important requirements of furnace volume, height and disposition of heat absorbing surface might be entirely absent. The whole thing was then bricked in with, at best, the hope that it might work.

If the furnace was inadequate, if there was smoke, poor combustion, slagging, excessive deterioration, limitation of ratings or any of the score of difficulties, was any blame assumed by the boiler salesman? No, he had only guaranteed exit temperatures and did not take any responsibility for furnace trouble, even though he sold a boiler with half the furnace-width and with less than half the radiant heat-absorbing surface that a competitor might have offered.

Did the stoker salesman take any of the blame? A definite amount of coal must be burned per hour to obtain the desired rating. If the furnace is so shallow that the volatiles get to the tube bank without burning, it cannot be blamed on the stoker. If the furnace, for the rating desired became too hot, with excessive deterioration, what could the stoker man do about it?

The installation as a whole was inadequate, unsatisfactory and largely a failure in spite of the standard stock boiler and stoker specifications and guarantees.

Unit Responsibility One Answer

The question then arises, how should such equipment be bought to insure the desired over-all results? Unit responsibility—one manufacturer offering the complete set-up, is one answer. It has, however, the drawback of leaving no choice to the purchaser as to the individual elements in the combination. Many engineers desire to select and make their own combinations to obtain what, in their own judgment, is the best equipment in each case. Without doubt, these engineers will, in the future, as they have in the past, insist on buying equipment of their own choice. This requires, however, that specifications for such equipment be so drawn that responsibility for satisfactory operation of the completed unit will be properly split among the different contractors.

In any installation, a given amount of steam is desired at a given pressure and temperature. It is desired to operate with a given over-all efficiency and certain types of fuel. This gives the starting point. From it, the total heat input to the furnace can readily be computed.

The fuel-firing equipment manufacturer should stipu-

late the furnace width, depth and height necessary to liberate the required heat from the stipulated fuel with his particular equipment. He should then be called upon to guarantee the various mechanical details and efficiency of his equipment, and also combustion efficiency with the specified fuels and percentages of excess air.

It is to be understood that by combustion efficiency is meant the ratio of the heat available in a given quantity of fuel to that liberated and made available to the boiler. It should be measured by deducting the losses due to the fuel-firing equipment and furnace such as combustible in refuse or otherwise unburned, and moisture and setting-radiation losses.

The function of the boiler is to absorb as much of this heat as possible and in a manner to prevent excessive temperatures in any portion of the furnace. Starting with the type of firing equipment and the specified furnace volumes, as well as combustion efficiency and fuel bed areas or flame volume and placement, the boiler manufacturer should guarantee the over-all efficiency, which includes radiation and flue gas losses. Since the placement of radiant heat-absorbing surface in the furnace is the controlling factor as to temperatures, he should guarantee maximum temperatures in any portion of the furnace, or more simply, operation without difficulty or deterioration due to excessive temperatures or slagging of the ash on furnace walls, floor or heat absorbing surfaces.

The construction of the furnace itself, if not made a part of the boiler contract, then becomes a comparatively simple proposition, since the responsibility for space and volume sufficient for complete combustion rests on the fuel-burning equipment manufacturer and the responsibility for efficient absorption and for excess furnace temperatures rests on the boiler manufacturer.

This is no less true in the case of the simplest type of boiler having no water walls or any construction other than a straight bank of tubes. It must be appreciated that the man who attempts to sell a boiler half as wide as required, or with half the necessary area exposed to the fire, is placing limitations on the furnace that do not obtain in a wider boiler, although they both may be rated at equal horsepower.

On the above-outlined basis, there is no reason why the power engineer cannot obtain the over-all results he may expect, with a logical fixed responsibility for each and every element entering into the installation, placed definitely where it belongs so that there can and will be no possibility of shifting responsibility. As a matter of fact, many forward-looking engineers have employed this method of specifying boiler installations for some time, with absolute assurance of obtaining the desired results.

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Power-Factor Correction An Economical Problem

By OTTOMAR H. HENSCHEL*

POWER-FACTOR correction often offers opportunities for making reductions in power costs and improved system operation. As an approach to the solution of the problem, in all cases a survey should be made of the sources of low power factor. This will include a check on all of the equipment connected to the system. Such a survey will preferable include both load and power-factor readings. In the absence of recording wattmeters and power-factor meters, indicating wattmeters for determining the kilowatt load and indicating ammeters and voltmeters may be used to obtain the kilovolt-ampere load.

Where motors are involved it is frequently found that overmotoring is one source of low power factor. Where such a condition exists it is always preferable to correct it in so far as is economically possible. In some installations it is possible to attain a satisfactory power factor by rearranging the motors to get them properly loaded. After the system has been remotored the power factor should again be checked to determine the improvements made.

The next step in a power-factor correction program is to determine the most suitable size, type and capacity of corrective equipment required. This may resolve itself into the problem of choosing between synchronous motors or static condensers. Some major piece of equipment may require a motor of such capacity as would favor the installation of a synchronous motor. The installation may include a large number of small motors, in which case placing one or more static condensers on the system may prove the best solution to the problem.

The benefit derived from improving low power factor depends on local conditions, and is a question of economic return. It is frequently found that distribution lines are overloaded. Where a low power factor exists the overloading may be due entirely to this cause. Correcting the power factor will result in reducing the current, which is the equivalent of increasing the capacity of the existing lines.

It is interesting to note how this phase of the problem works out. Assume the 100 per cent copper requirement with 100 per cent power factor. The increased copper with decreased power factor is as given in the table, based on the same power loss in the lines. It will be seen that where a power system is operating with a 70 per cent power factor double the copper is required to transmit a given kilowatt load with the same losses in the line as when the power factor is 100 per cent.

Many of the public utilities penalize consumers for low system power factors. In other words, one might say consumers may derive a so-called bonus by improving system power factors. It is in cases of this kind where the greatest economic returns are generally realized from power-factor correction.

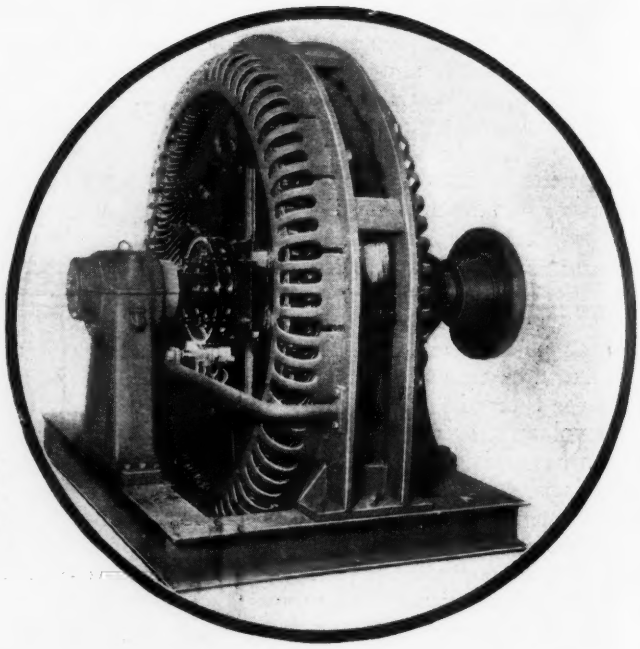
What may be expected in the way of savings depends on local conditions and rate schedules employed by the utility company. There are no set rules and each case calls for its individual solution.

RELATION BETWEEN POWER FACTOR AND SIZE OF CONDUCTORS

Power Factor, Per Cent	Copper Size Required, Per Cent
100	100
95	111
90	124
85	135
80	156
75	178
70	204
65	237
60	278
55	330
50	400

*Consulting Engineer, Milwaukee, Wis.

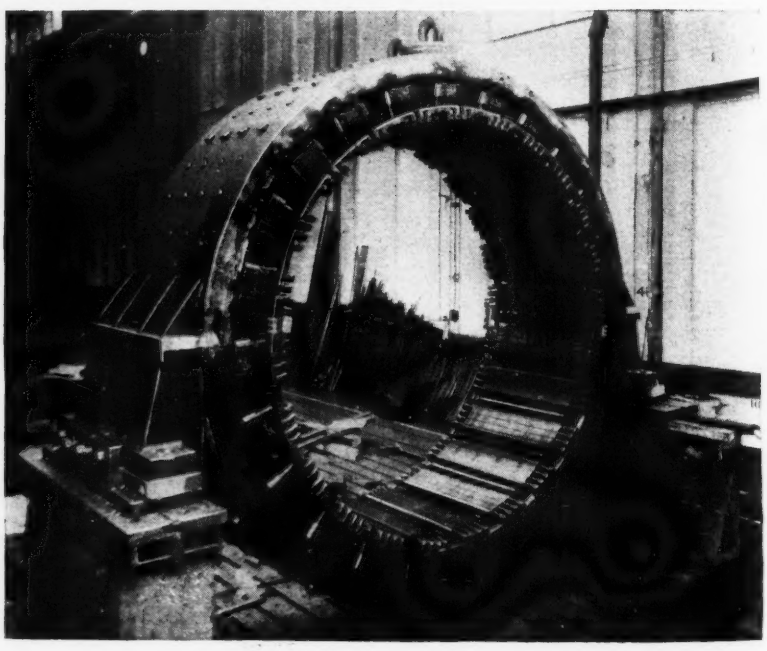
WELDED STRUCTURES USED IN POWER EQUIPMENT CONSTRUCTION



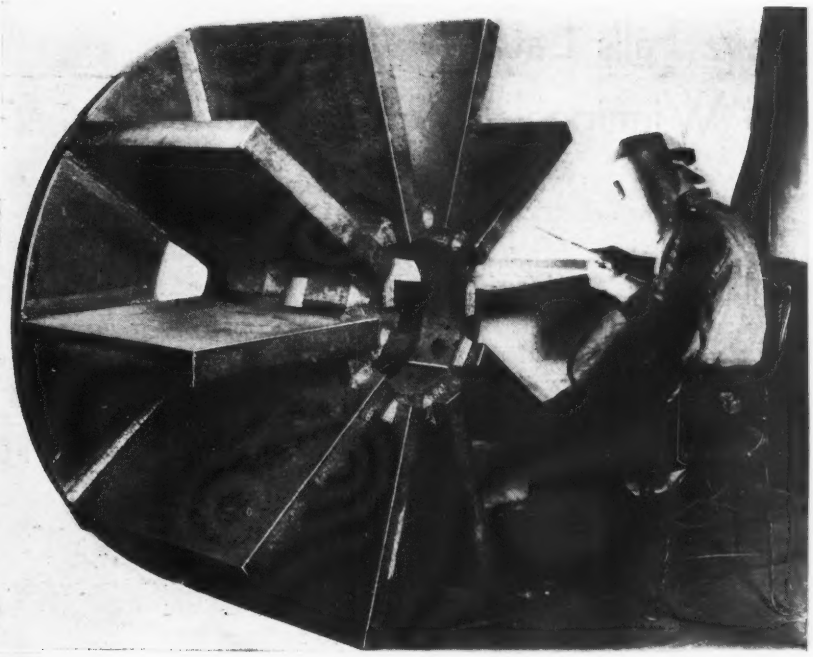
Synchronous motor built in quite large numbers, the frame, rotor and bedplate of which are made of welded construction and the bearing pedestals are made of cast iron

Photos by courtesy of the Westinghouse Electric & Manufacturing Company

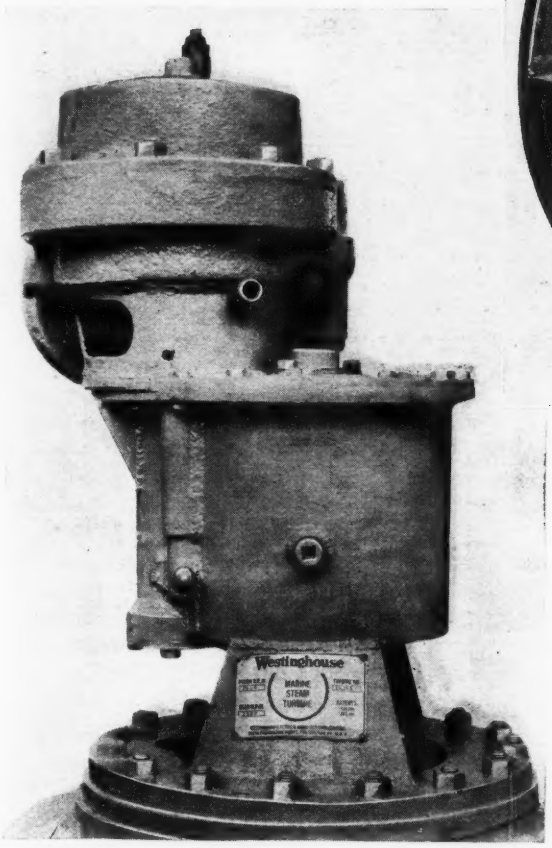
Bedplate of 350-hp. high-speed diesel engine constructed by welding. The design consists mostly of flat thin walls which made their replacement with plate construction fairly simple. Because of the many intricate shapes in the engine's frame it was more economical to make this a cast construction



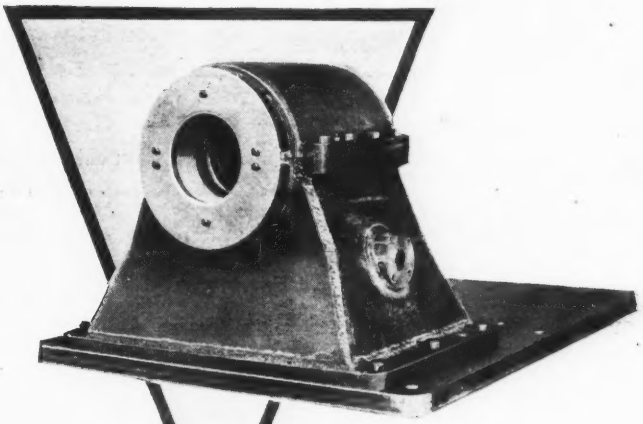
Making the frame of this 7,000-hp. direct-current motor by welding made possible quick delivery of the machine. The main frame is composed of 9-x30-in. steel bars rolled to shape and welded



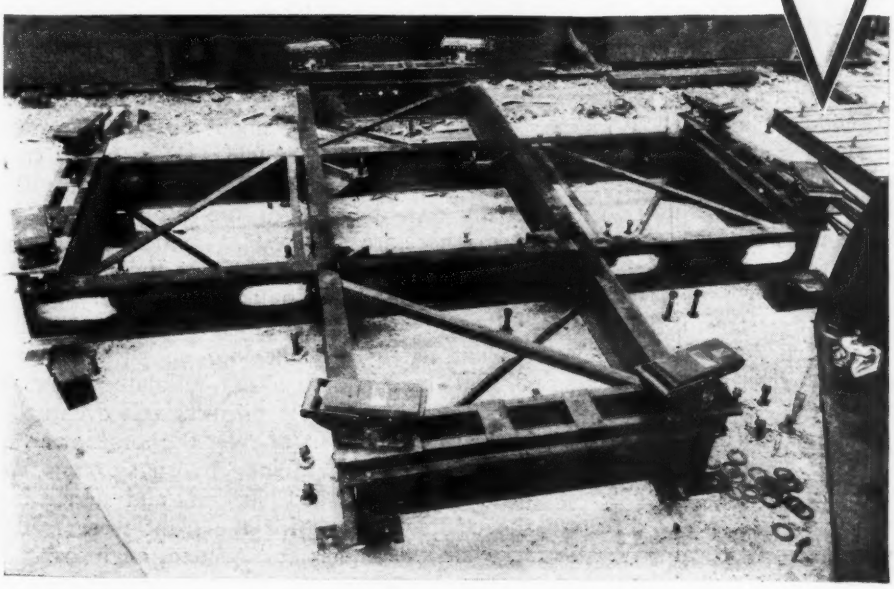
Spider for the armature of a large direct-current motor, of simple design but subjected to very high stresses due to reversing service, in the construction of which welding was more economical than casting



In the construction of welded steam turbines there are several parts where castings are used to advantage. Some of the parts with cored passages are cast and then welded into the structure as shown



A large bearing pedestal made of welded construction that can be made more economically by casting if more than four of one design are needed. If there are only a few pieces, saving the pattern costs usually makes welding cheaper



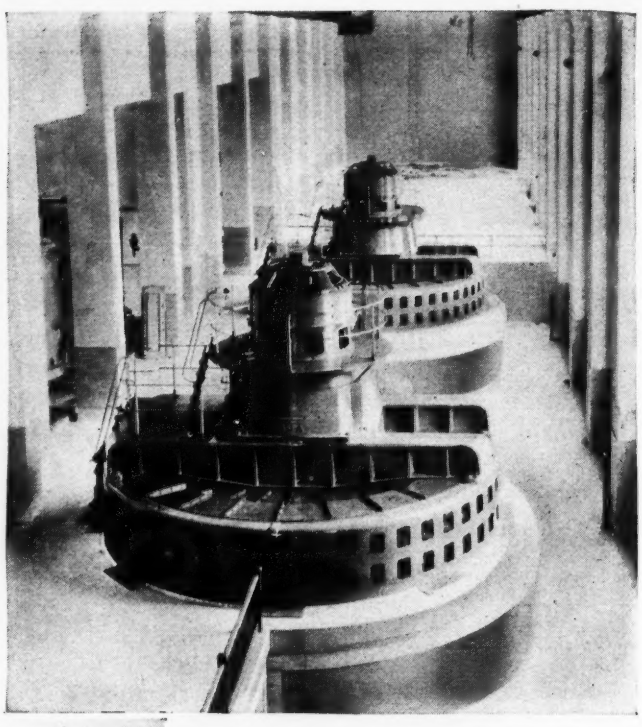
Structure to support the lower guide bearing and brake shoes for a large waterwheel generator is a combination of fabricated shapes and steel castings assembled by welding. The guide bearing is supported by the four steel castings welded to the beams forming the structure's center

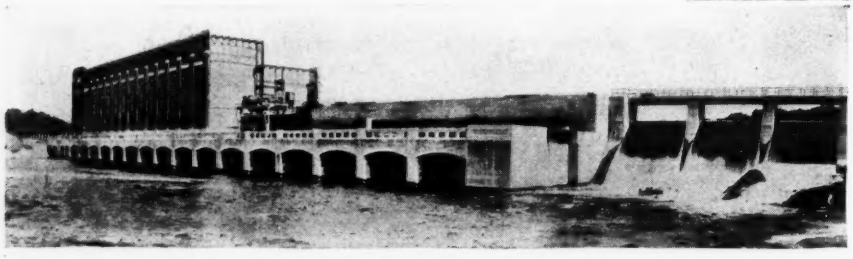
Slave Falls Latest Addition To Winnipeg's Hydro System

CONSTRUCTION work was started on the Slave Falls hydro-electric development of the City of Winnipeg, Manitoba, in 1929 and the first unit was put into operation Sept. 1, 1931.

The Slave Falls site is situated approximately six miles south of Pointe du Bois. In the license awarded by the government, authority was given, among other things, to raise the water at the Slave Falls plant by means of dams, so that all the available flow of the river between Pointe du Bois and Slave Falls is concentrated at the new plant. This provides an average head of 30 feet.

There are seven dams in the project. A rock-filled dam 550 ft. long with a maximum height of 80 ft. is of the non-overflow type. A sluiceway dam 446 ft. long, contains seven 21 by 50 ft. gates and between these are piers 12 ft. thick. The spillway dam is 503 ft. long, contains twenty-eight 5 by 15 spillway gates, and connects with the sluiceway.





Above—Two 12,000-hp. units in initial installation at Slave Falls plant

Left—Slave Falls plant is designed for an ultimate capacity of eight 12,000-hp. units under a 30-ft. head

One of the most imposing pieces of construction is the ice-sluice dam, which contains three 5 by 30 ft. gates with 5-ft. piers between them. This dam is 113 ft. long, has a maximum height of 50 ft. and is connected with a non-overflow dam having a maximum length of 110 ft. A non-overflow dam with a concrete-core wall is 330-ft. long with a maximum depth of core of 50 ft. The spillway dam is 330 ft. long and contains fifteen 5 by 15 ft. spillway gates.

Power-House Construction

The power house is erected between the spillway dam on the south and the ice-sluice dam. It has a total substructure length of 583 ft. and is 111 ft. wide. The total length of dams and power-house construction is approximately 3,000 ft., which, with the island, spans the river.

The plant involved no unusual features in design with the exception of the rock-fill dam in the west channel. This dam is carried on a foundation of gravel and bounders and special care has been taken to seal the material overlying the rock in the bed of the stream. Below the minimum water-level during construction this sealing was accomplished by driving heavy steel-sheet piling, and above this elevation the dam is faced with 24 in. of reinforced concrete and provided with sealed joints in anticipation of a certain amount of settlement. A sand and gravel blanket is deposited over the face of the whole dam.

At present the power house contains two vertical turbine units, each of 12,000-hp. capacity, and two 500-hp. station-service units. To transmit power from Slave Falls to Winnipeg four transmission line circuits, 86 mi. in length, will be required and will operate at 132,000 volts. Between Slave Falls and Pointe du Bois a transmission tie-line of two 132,000-volt circuits has been constructed.

Normal regulated flow of the river at the plant is estimated at 20,000 sec.-ft. Present flow is approximately 12,000 sec.-ft. The greatest flow ever recorded at this point is 86,500 sec.-ft. Based on the normal flow, with a daily load factor of 65 per cent, no difficulty is anticipated in developing the designed maximum of 96,000 horsepower.

Between Pointe du Bois and Great Falls on the Winnipeg River, a distance of about 50 mi., there are now four major power developments, all of which contribute to Winnipeg's power requirements. Besides the two municipally owned plants of the Winnipeg hydro-electric system, there are the 168,000-hp. development of the Manitoba Power Company at Great Falls, and that of the Northwestern Power Company, subsidiary of the Winnipeg Electric Company, at Seven Sisters Falls. The latter plant, lately brought into operation, is developing 37,500 hp., and has an ultimate designed capacity of 225,000 hp. These projects will eventually represent a total development of 594,000 horsepower.

J. W. Sanger, of the Winnipeg hydro system, was chief engineer overseeing construction, and under his direction the complete plans for the plant were made. W. D. Mackenzie was and is still resident engineer.

PRACTICAL AIDS TO OPERATION

Pressure Gage Maintenance

IN ONE PLANT a maintenance expense amounting to considerable in a year was the item of pressure gages. This expense was due to the destruction of movable parts in the gages, especially the expensive high-pressure instruments.

Vibration, or rapid, continuous changing of tube, sector and pinion positions, was the usual cause of short life. It was necessary to ascertain whether the vibration was being transmitted through the metal walls of the gage line from the machine to which it was connected or if it was being transmitted through building construction to the gage mounting. In the former case a firm clamp was constructed to support the gage line just below the gage and the line bent into a six- or eight-turn spiral just below the clamp. A 1 to 6 in. spiral was used, depending on the size and material of the pipe.

If it was found that vibration was being transmitted from high-speed machinery through the building construction to the gage mounting, the gage was protected by mounting it on a cork-base several inches thick and in turn the base was bolted to the panel.

If rapid pressure fluctuations were causing excessive wear in the gage, these were dampened sufficiently to eliminate unsteady action by a "dampener" or "snubber."

H. M. SPRING.

Milford, N. J.

Water at the Price of Coal

BITUMINOUS COAL delivered in trucks to small steam plants often comes water-soaked, the wetting being done in the chutes through which the trucks are loaded. The purpose is to avoid clouds of dust during loading as well as when trucks are dumped. In fairness to the purchaser, this wetting should be done after the trucks have been loaded and weighed. A gallon of water weighs a fraction more than eight pounds, and an ordinary truck load of soft coal will soak up many gallons.

The engineer in charge of a plant consuming about five tons of coal per day, and costing $3.50 per ton, determined to find out how much the concern was paying for added water. A little experimenting showed him that the nut coal he was using, when separated from the dust, absorbed a maximum of about 300 lb. of water per ton, while the dust absorbed a quantity equal to its own weight. The experiments also showed the absorptiveness of anthracite to be comparatively low, the smooth, hard lumps taking up not more than 10 lb. of water per ton.

The engineer assumed that about 100 lb. of extra water in each ton of fuel dumped into the bunkers would be a conservative estimate. Therefore, the $3.50 paid per ton was only buying 2,000—100=1,900 lb. of usable coal.

The loss due to evaporating this 100 lb. of water in the furnace, however, was additional to this. On the basis of the heat lost up the stack in the resulting water vapor, 10 lb. of coal out of each ton was required for this evaporation and therefore only 1,890 lb. of usable coal remained.

Considered on a price basis, the actual usable coal received was costing him

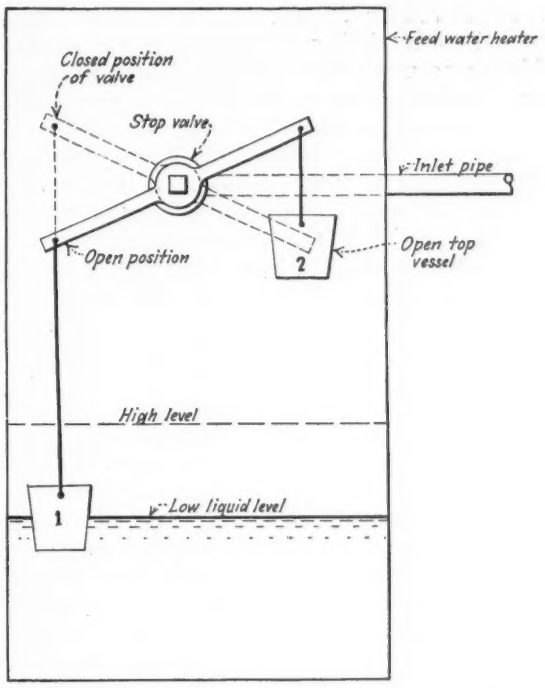
$$\frac{2,000}{1,890} \times \$3.50 = \$3.70 \text{ a ton}$$

Thus the net effect of this wetting was to add twenty cents a ton to the coal price.

Chicago, Ill. J. D. ARNESTER.

Improvised Heater Water-Level Regulator

A LIQUID-LEVEL REGULATOR operating on the displacement principle, using the liquid being handled to displace a predetermined amount of the same liquid, is arranged as shown in the accompanying illustration. Two open top vessels of the same size and weight are suspended from a lever that operates a stop valve in the inlet line. Vessel No. 1 is hung about twice as far from the stop valve stem as is vessel No. 2, which gives it a leverage advantage over No. 2 when the liquid level is low. Both vessels are full of the liquid being handled. When the liquid level rises, submerging No. 1, the decrease ineffective weight on the lever allows No. 2 vessel, which is hung above the liquid level, to move the valve lever to the closed position.



Arrangement of displacement type regulator

We are using this device in a boiler feed-water heater and its operation is perfect.

Des Moines, Iowa. W. W. CARTWRIGHT.

CURRENT COMMENT

Red or White Lead as a Pipe Compound

THE DISCUSSION by readers of *Power,* in the Jan. 5 number, concerning red lead and white lead as a pipe-joint compound seems to indicate that some difference in opinion exists as to what is considered a good pipe-joint compound. Mention was made in the discussion of the necessity of good threads, but good threads are not really cut on all pipes, hence the dependence upon various extra-hard-setting compounds and lamp wicking for tight joints. A pipe-joint compound should not be depended upon to hold a joint in a tight condition when it is possible to cut good threads.

A good compound is one that serves as a lubricant in the making up of a joint and spreads out so that when the joint is made there will be a thin layer of compound between the male and female threads. This will act as a rust preventive and permit disconnection at any time. Fresh red lead, white-lead preparations, graphite pastes and other similar commercial preparations sold for this purpose are satisfactory. There is not much difference between them except that some seem to harden more quickly than others after being on the pipe for a relatively short time. While this does present some difficulty in disconnection, a few blows from a hammer will loosen this set. The use of red-lead or white-lead compounds is so wide that hardly any comment need be made, but the use of litharge and glycerine and lamp wicking on steam and water piping deserves some discussion.

To seal an iron, steel or brass pipe in water or steam service with litharge is usually evidence that poor threads have been cut and that some makeshift is necessary to hold these poor threads tight. In cases of this kind, examination of the threading equipment will reveal improperly adjusted dies or worn and warped stocks.

Improperly selected pipe material will result in poor threads and leaky joints which require extraordinary effort and more than a metal-to-metal joint to be tight.

The piping most commonly used around the power plant is steel, wrought-iron, cast-iron alloy and brass. Steel piping for most services is in two classes, open hearth and Bessemer. Open-hearth steel is difficult to thread with standard equipment; Bessemer steel will thread more readily and should be chosen for piping that is to have screw-thread joints.

Genuine wrought-iron pipe will thread with no difficulty at all, and it is recommended where freedom from corrosion is considered, in such lines as boiler-feed piping condensate piping from drips and traps and heating-system return-line piping. In addition to the non-corrosive feature of this pipe, its excellent threading qualities permit tight joints that hold high vacuums without the aid of pipe compounds.

Cast-iron alloy pipe threads easily and screws up well with the regular screw fittings. It should be used where tight joints are required in lines where corrosion and erosion are factors.

Brass piping, iron-pipe size, usually requires special dies to prevent the thread from choking while being cut, and these dies require, contrary to the opinion of many, a good supply of oil to prevent the dies from burning and softening, thus rendering them indifferent for brass-thread cutting.

Threads on brass piping are often lamp wicked as a precaution, but this wicking cannot be depended upon, as it will rot, and if subjected to heat will burn. A good joint compound for brass piping is lead filings and oil. When applied to the male thread the lead will soften and fill up any small spaces that exist and will provide a tight and permanent joint. Some of the lighter brass fittings spread when being made up; the lead filings will fill up the space occasioned by the spread, which otherwise would require lamp wicking.

In cases of oil, air and hydraulic piping, litharge and glycerine make an excellent compound, but if the joint is subject to vibration and temperature changes of any consequence this compound will crack. It is usually better to back-weld the fitting for a tight joint. Many of the joints made up with extra-hard-setting compounds, despite the care taken in the application of the compound, leak when put into service. This may be explained easily: Joints when being made up at the point of installation are often subjected to strains by the lining up of bolt holes in the flanges, by the facing and tightening of collar unions, and by tightening up of flanges on short tangents. It is this strain that cracks the sealing compound.

Expansion and contraction of steam pipes also render a joint compound of the hard-setting type ineffective, by thrusts at anchor points, cold-springing in jointing, abnormal sets in the piping cause by improper and ineffective guides for the expansion movement, the swiveling of fittings by the linear expansion of the line and by bending moment at joints.

Brooklyn, N. Y. WILLIAM ANDERSON.

Air Heater Corrosion

THE ARTICLE by Louis C. Whiton, Jr., in the Dec. 28, 1931, number on "Practical Comments on the Maintenance of Air Heaters," is an excellent summary of air heater troubles with their causes and prevention, and all engineers with experience on air heaters will agree that it is not always fair to blame the manufacturer for high maintenance charges due to the corrosion and blocking of gas passages. My own experience with both regenerative- and plate-type heaters confirms most of what Mr. Whiton has to say, but he also considers that manufacturers have been rather slow in understanding the causes of the trouble and passing their remedies on to the public.

The majority of air heater troubles are caused by the deposition of moisture from the flue gases on the plates (or tubes) owing to the fact that the plate temperature is below the dew point of the gases. It is the difficulty of determining exactly what the dew point is that has delayed the cure of the troubles. In an article in *Power*, March 24, 1925, on "Economizer Corrosion and the Dew Point of Flue Gases," I discussed the rather similar problem of economizer corrosion and presented a chart for the determination of the dew point based on the

humidity of the outside air and the percentages of moisture and hydrogen in the fuel. Quite recently excellent work on the whole question of the determination of the dew point and on corrosion in general has been carried out by Dr. H. F. Johnstone and is published in the University of Illinois Bulletin No. 13, (see also *Power,* May 26, 1931). Dr. Johnstone criticizes my method because "a trace of sulphuric acid vapor materially affects the temperature at which the fluid will first be formed." Dr. Johnstone's criticism is sound, but his own records do not support his statement that the chart may introduce an error in the dew point of from 20 to 200 deg. F. too low.

Actually, with an average fuel of about 1 per cent sulphur as fired the error involved will be found to be negligible, or within the experimental error in the determination of the dew point. While I have had no experience with fuels of over 4 per cent sulphur content, the chart in the original article will give satisfactory results with fuels normal in sulphur. It will also be found that there are not sufficient vapor-pressure data to use Dr. Johnstone's method except for very high sulphur coals, and the method I used in preparing the chart must be followed in the majority of cases. It is hoped that Dr. Johnstone will be able to extend the scope of his method, which is undoubtedly excellent and based on correct premises.

While the calculation of the dew point may yield useful results, it is clearly better to make actual determinations when possible. The apparatus required is simple, and a satisfactory instrument is described in the third edition of "Sampling and Analysis of Gases" (Carnegie Steel Company, Pittsburgh, Pa.). Dr. Johnstone uses a method which is essentially similar; his apparatus appears complicated because he wished to obtain a record and not an indication of the dew point. A cheap and reliable apparatus can be made in a short time and requires no great skill in use.

Once the dew point, under the most adverse conditions, has been determined it is a simple matter to find by means of thermocouples whether the plate or tube temperatures approach the dew point. I have done this on a plate-type heater with most interesting results. Corrosion will almost invariably occur just where theory would lead one to expect it, that is, where the plate temperature is likely to be the coldest. The plate temperature is not, or is very rarely, a mean of the gas and air temperatures, but is also a function of the rates of heat transmission from the air and gas on each side of it. If, for instance, the plates are dirty on the gas side they will tend to approach the temperature of the air on the clean side. A dead gas pocket will have a similar effect.

As most air heaters are constructed for counterflow the gas and air at their coldest temperatures at the chimney end of the heater. Here it is possible for the plate temperatures to fall below the dew point even in comparatively warm weather, the condition, of course, being aggravated by cold weather. The general rule in operation is to do nothing which will lower the plate temperature. An air bypass is essential.

Mr. Whiton has mentioned recirculation of the heated air to the inlet as a means of keeping up the plate temperature. Except as a temporary measure this is inefficient practice, because, in addition to the increased fan horsepower, the efficiency of the air heater is lowered. A better method, if it is possible, is to convert all or part of the air heater to work in parallel rather than counterflow. There is a loss in efficiency through working in parallel rather than counterflow, but for the same loss in efficiency as would be caused by recirculation the mean plate temperature is much higher. It is standard modern practice to work convection steam superheaters in parallel flow to keep down the tube temperatures and prevent internal and external oxidation. The same argument may be applied to air heaters to keep up the plate temperatures. At the same time, assuming that it is a paying proposition to reduce the exit flue gas temperature to a value where corrosion is the limiting factor, any means of raising the temperature of the metal plates or tubes will extend the working range of the air heater.

New Castle, England. B. M. THORNTON.

Operating Steam Engines Without Lubrication

IN RESPECT to the question and answers on the nonlubrication of a steam-engine cylinder, which appeared in *Power,* Feb. 9, the generally accepted rule is that steam engines cannot be successfully operated without the use of cylinder lubricating oil where superheated steam is employed.

This is a general and safe rule to adhere to, but can, of course, be departed from, dependent upon a number of considerations, such as initial steam pressure, amount of superheat, type of engine and composition of rubbing surfaces.

In the case of a two- or three-cylinder compound or triple-expansion engine the effect of steam superheated to a small degree entering the high-pressure valve chest and cylinder will be lost in the lower-pressure stages, the steam becoming wet, and in a case of this nature it would be necessary to lubricate the high-pressure line only. With a high, or even a moderate, degree of superheat it is advisable to lubricate all cylinders and valve chests.

In any event, with steam superheated beyond the saturated temperature it will be found necessary to swab the piston rods and valve rods where these pass through the packing glands and stuffing boxes.

Absence of cylinder lubrication, even with engines operating on saturated steam, results in increased steam consumption due partly to increased friction and partly to leakage of steam at the valves and pistons, for there is an absence of the seal produced by an oil film.

In order to minimize excessive wear, possible seizures and operating costs, make use of cylinder lubrication where superheated steam is present. O. V. STEGALL,

Leeds, Eng. Capt. R. E.

Unbalanced Refrigerator Load

IN THE Jan. 26 number of *Power* on the pages devoted to readers problems, there was a question with answers on the balancing of the load on four refrigerator boxes. I believe the trouble is that the plant is short of liquid ammonia. It may be the receiver is too small. We had the same experience and found we were short on ammonia. If the plant has no gage glass on the receiver I would put one in as soon as possible.

W. H. OLIVER,

Engr. Southwest Utility Ice Company.

Osawatomie, Kan.

READERS' PROBLEMS

LOW SUCTION PRESSURE—*The temperature of a chill room is kept at —21 deg. F. The compressor suction pressure by a gage is 20 in. of vacuum, while the discharge pressure is 170 lb. Is such a vacuum necessary on the suction to have a —21 deg. temperature in the chill room? Does not the high discharge pressure indicate foreign gases?* C.S.

The ammonia pressure corresponding to an evaporating temperature of —21 deg. F. is 3.1 lb. gage. A 20-in. vacuum corresponds to a boiling temperature of below —60 deg. F.

The difficulty is too small a suction line, insufficient feed to the evaporator coils or too small a coil surface. If the suction line is too small, there will be a large pressure drop in the line between the coils and the compressor, resulting in a low pressure at the compressor. If insufficient ammonia is fed the coils only a part of the coils will be evaporating ammonia and the vapor will be insufficient to maintain the evaporating pressure through the coil. As a result the vapor becomes superheated and the compressor suction pressure drops. If the coil surface is small, it is necessary to have a large temperature difference between the ammonia and the room. If the latter is at —21 deg. F. it is possible that the ammonia evaporating temperature may need to be as low as —40 deg. F., which will give a pressure of 8.7 in. of vacuum. The pressure drop through the suction line might easily reduce this to 20 in.

The fact that the float control does not work is a strong indication of too little ammonia in the coils.

The discharge pressure is high if the water temperature is around 80 deg. F.

ADVANTAGE OF SWING CHECK VALVES—*Is a swing check to be preferred over a poppet check?* A.B.D.

The swing type has the advantage that it gives a freer opening, is less likely to clog and the seat is subject to less wear.

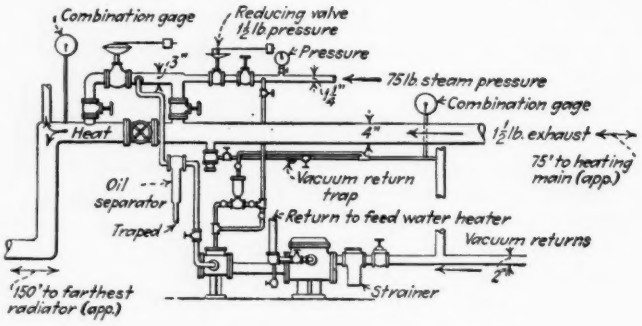
▼ ▼ ▼

Many Causes Suggested For Trouble With Heating System

IN THE ILLUSTRATION is a sketch of a problem in heating. Steam is being used from an intermediate steam pressure, although originally the heating was to be done by exhaust steam, especially in mild weather.

The problem is—Why does this present hook-up not work when the valves are changed to use exhaust steam? As soon as the change is made the vacuum pump loses its vacuum, 8 to 9 in. and begins to run a very undesirable speed. There are two combination pressure and vacuum gages; A is connected to the main heating line and B is connected to the vacuum return; A may have 1½ lb. pressure from either the exhaust or from the intermediate pressure reduced to 1½ lb. pressure. As soon as exhaust steam is used B loses its vacuum and in a short period of time will read the same as A.

R.E.F.



Arrangement of valves on heating system

THE FACT THAT no trouble is experienced with the heating system when using steam of an intermediate pressure reduced to 1½ lb. gage and that the exhaust steam is also at 1½ lb. eliminates the possibility of air leakage between the heating system and the source of supply.

Study of the sketch reveals a drain in the 4 in. exhaust supply line directly above the vacuum pump. This drain is connected through a vacuum-return trap to the vacuum-return line not far from the pump suction. Into this drain line is also connected a pipe leading to the vacuum-controlled pump governor and the combination gage *B*.

Assuming that this drain is closed or the 4-in. exhaust supply line is cold, steam being shut on at some other point when the higher pressure steam is used through the reducing valve, this hook-up will cause no trouble. However, when the low-pressure main is used and the drain valve opened condensate at a temperature corresponding to the saturation point at 1½ lb. pressure starts flowing into the vacuum-return line, carrying a vacuum of 8 or 9 in. Under these conditions every 42 lb. of condensate will generate 1 lb. of flash steam with a volume of about 37 cubic feet.

It is also very likely that the trap is leaking and passing some steam into the vacuum line. This will not only overload the pump with uncondensed vapor but it will affect the pump governor by building up a slightly higher pressure in the small pipe. This will cause the pump to overspeed and lose some of its efficiency. It will also cause the vacuum gage to show a slightly higher pressure than actually exists in the vacuum line.

If it is impossible or undesirable to drain the exhaust line to a hotwell or to the atmosphere, the trouble can be overcome by running the drain through a radiator or pipe coil or by carrying the drain line back as far as possible from the pump suction before tying into the vacuum line and then adding some of the plant make-up water, using the suction line as a jet condenser.

RAYMOND SEPTOR.
South Amboy, N. J.

ACCORDING to drawing published I presume that the system is supplied with steam both ways from reducing valve, and that the governor and gages are in about the center of the system.

If this is the case, the trouble is caused by the hot condensate passing through trap, that no doubt passes a certain amount of steam, which in turn will kill the vacuum. This applies when the system is using exhaust steam. When live steam only is being used it is much drier and very little condensate passes through trap.

The cure for this would be to connect the pump governor and gage *B* to the vacuum return line to the pump after the riser which leads to trap at the reducing valve, thereby receiving the correct vacuum on the system. It may also be advisable to have a small water seal on riser behind pump.

HAYDON B. BROEMEL,
Essex County Penitentiary.
North Caldwell, N. J.

MY SOLUTION of this problem is as follows: While operating the system with exhaust steam, all condensation in the 4-in. exhaust main must be discharged by the vacuum return trap, indicated above the vacuum pump. Traps for drips, of this character, are usually of the float type with thermostatic air bypass and discharge the condensation at practically the same

temperature as that of the steam, almost continually.

As the combination gage for the return system is located in the run-off from the trap, it will be subjected to the condensate at steam temperature, which will prevent the maintaining of a vacuum at this point due to the condensation flashing back to steam with slight reduction of pressure.

The vacuum regulator in the steam line to the vacuum pump is also piped to the same run-off connection, which accounts for the pump operating at undesirable speeds, as the pressure on the regulator line opens the control valve wide.

These connections should be made to the main return line between the pump suction and the first branch to the return line, to eliminate the effect of the condensation from the drip trap.

JOHN F. WOLFF, JR.

Philadelphia, Pa.

THERE ARE two possible causes of the loss of vacuum. One is the presence of a greater quantity of "non-condensable" gases than the vacuum pump is capable of handling. The other is the supply of more steam than the condenser is capable of condensing. In this problem there is no reason to believe other than that the exhaust steam should be condensed as easily as the higher pressure steam which has been throttled. Thus the exhaust steam must contain more "non-condensable" gases than the higher pressure steam. An examination of the exhaust steam system should be made to determine where these gases are entering, and then stop their entrance.

The unusual part of the piping arrangement, as shown in the drawing, is the return of the discharge from the vacuum pump to the feed-water heater. An inspection will probably reveal the fact that the gases leaving the vacuum pump are merely being circulated through the feed-water heater and back into the exhaust steam system and are, therefore, not being eliminated. Discharge these "non-condensable" gases to the atmosphere. That is where they belong. Then, if the vacuum pump is large enough, there should be no further trouble maintaining the desired vacuum.

W. S. HOBBS.

Media, Pa.

IN THE ABSENCE of full information and details of piping layout at source of exhaust steam, it must be assumed that the 75 ft. of 4 in. exhaust pipe shown is filled with steam and properly drained at the time the valve shown in this line is opened for the use of exhaust steam in the system. If there is no steam in this 75 ft. of pipe and steam is turned into it, displacing the air, this air will be pushed ahead into the heating system, quickly destroying the partial vacuum. This vacuum will be restored again as fast as the air is removed by the pump, provided no more can enter.

Certain types of back-pressure valves, such as the butterfly and similar valves, do not close tight against atmosphere pressure. This type of valve is all right where the supply of exhaust steam is sufficient to maintain a pressure against the valve disk when supplying the heating systems. Sometimes the requirements of the heating load are in excess of the exhaust steam supply, which is condensed fast enough to permit air to enter through the back-pressure valve. This would be sufficient to prevent building up a vacuum with the pump.

The cause of lost vacuum is not in the arrangement of valves and piping as shown in the sketch. It is possible that the vacuum return trap indicated in sketch is at fault and should be examined, but this leakage would necessarily have to be very large to affect the pump very much.

More detailed information is necessary in order to prescribe a cure for this trouble.

W. F. Cox.

Kansas City, Mo.

THE CONDITIONS of the steam from the two supplies, other than the pressure, are not given.

It is usual to find steam exhausting at 1½ lb. back pressure to have some moisture content or to be saturated at best, while steam taken from an intermediate pressure of 75 lb. is usually saturated if not containing a few degrees of superheat.

When saturated steam passes through an orifice or reducing valve from a higher pressure to a lower pressure, without doing any work or having any heat extracted from it, it becomes superheated.

For the sake of discussion, let us say that the two steam supplies are both of saturated steam under the two conditions of 1½ lb. and 75 lb. Now under these two conditions there is approximately 33 B.t.u. more heat per pound in the higher pressure steam than in the lower pressure.

When supplying the heating system with steam from the exhaust of 1½ lb. pressure we are using saturated steam, while the steam when used from the 72 lb. pressure supply will have approximately 68 deg. F. superheat after it has passed through the reducing valve, provided it was saturated at the higher pressure.

It is very likely that there are one or more faulty traps on the various radiators of the heating system. If such be the case, a certain amount of steam is allowed to pass into the hot-water return line.

My analysis of the situation is that when the exhaust or saturated steam is being used, the steam passing through the defective traps is condensed, or practically condensed, before it returns to the vacuum pump. However when the system is being supplied from the intermediate pressure the steam that passes through the defective traps has such a high heat content that it is not nearly condensed when it returns to the vacuum pump. In fact, part of the condensate in the line will no doubt be evaporated due to the extra heat of the superheated steam. This steam, of course, causes overspeeding of the pump, and the rise in pressure on the vacuum line.

This trouble could probably be corrected by repairing or replacing the defective traps.

R. F. SORRELLS.

Beaumont, Texas.

IT IS COMMON practice to admit live steam, at a reduced pressure, into a heating system, when the supply of exhaust steam is not sufficient. This procedure normally takes place without trouble, providing all equipment is in good order.

Basing this supposition on past experience, I believe R. E. F. will find an open connection between the exhaust line and the return line, which is not shown on the sketch. The drip connection from the exhaust line to the return line, with a vacuum return trap, is also a possible source of the difficulty. This trap may not be functioning properly, allowing the exhaust steam to bypass directly to the return line. In either case, a short circuit will cause the vacuum to drop and the pump to speed up.

Another factor that should be considered is air leakage. There may be some connection on the exhaust line side that is not tight, and if the leak is large enough it will cause the same trouble.

There is nothing mysterious about this heating arrangement. I am confident that if R. E. F. will carefully check all connections and traps he will find the difficulty.

ELMER N. ANDERSON.

Austin, Minn.

A Question for Our Readers

WE HAVE RECEIVED a car of diesel fuel oil, but find that it will not burn in our solid-injection engines, although it meets specifications that have resulted in suitable oil up to this time. What could be the cause of this difficulty? The oil comes from an Atlantic Coast refinery.

E.T.S.

Suitable answers from readers, if received promptly, will be paid for when published.

CALCULATING the Unknown Factors in FEED-HEATER OPERATION

By J. W. ROMIG
Corning Glass Works

The feed water heater receives prime-mover condensate, heating-system condensate, make-up water, exhaust steam, bled steam, etc. When their relation is understood any two unknowns may be computed

THE AVERAGE industrial power house is arranged so that exhaust steam from prime movers is discharged into a low-pressure piping system which connects to the plant heating system and at the same time is connected with the feed-water heater. In some plants the low-pressure steam system is also connected with a low-pressure turbine or the low-pressure stages of a mixed pressure turbine. Occasionally a check-up of the low pressure steam consumption of the heating system, of low-pressure process or of the turbine is desirable from the viewpoint of studying the heat balance.

To make a survey of the low pressure steam demands, the feed water heater requirements must be measured or calculated so that deductions of its demand may be made. The present article shows how these measurements and calculations may be made.

Computation or measurement of the low-pressure steam requirements of the feed heater are simplified when there is no heating system or other condensate return. However, when condensate from a turbine, from a heating system and from the low-pressure steam used for feed-water heating, enter the heater along with cold feed water, the calculation requires considerable juggling if the results are to be reasonably correct.

A feed heater makes highly efficient use of the heat in steam that has already been passed through an engine or turbine. The heat transferred to the feed water replaces coal which, when burned under very favorable conditions, may transfer only 75% of its heat to the steam.

One pound of steam leaving the boiler may have a total heat content of 1200 B.t.u. about 300 of which is in the form of heat of the liquid (water) and 900 in the form of vapor heat. None of the 300 B.t.u. can be used by the engine and only a few, probably 7 to 13 per cent of the 900 B.t.u. can be used by the prime mover. The remainder is available for low-pressure turbines, heating system, process and feed heating.

To check the low-pressure steam requirements of the feed heater, the following formulas are developed. In their final form they are applicable for computing the low-pressure steam distribution in any plant.

While the low-pressure steam may be metered, the results are not of a constant operating interest. Moreover, a meter restricts the flow of very-low pressure steam and drops the pressure or creates added back pressure on prime movers. Calculations are about the most practical method of checking the low-pressure steam distribution and the feed-heater steam consumption.

Let us consider a power station wherein the following conditions exist: Condensate is returned from a condensing turbine; condensate is returned from a plant heating system; low pressure steam at 3 lb. gage enters the feed heater; the makeup water is supplied from a water softener source.

The Fundamental Factors

The following symbols will be used in the study of feed-water heater problems:

Condensate from Prime Movers

T_c = Temperature of condensate from turbine or engine condenser, deg. F.

Q_c = Weight of condensate from turbine or engine condenser, lb. per hr.

H_c = Heat of condensate from turbine or engine condenser, B.t.u. per hr.

Heating System

T_s = Temperature of condensate from heating system—deg. F.

Q_s = Weight of condensate from heating system, lb. per hr.

H_s = Heat in condensate from heating system, B.t.u. per hr.

Cold Feed-water Makeup

T_f = Temperature of makeup, deg. F.

Q_f = Weight of makeup, lb. per hr.

H_f = Heat in makeup, B.t.u. per hr.

Hot Feed Water to Boiler

T = Temperature of hot feed water,

Q = Weight of hot feed water, lb. per hr.

H = Heat in hot feed water, B.t.u. per hr.

Low Pressure Steam

Q_l = Weight of l.p. steam, lb. per hr.

H_l = Heat in l.p. steam, B.t.u. per hr.

Total weight of water to boilers = $Q = Q_f + Q_l + Q_c + Q_s$.

Methods of Measurement

The temperature and the total weight of water fed to the boilers per hour are usually known, or the temperature of feed water and total steam evaporated may be known. The quantity of cold feed-water makeup is usually unknown, but it is easy to check the temperature. The quantity of condensate from prime-mover condensers may be metered or may be checked by spot weights for conditions approximating the average operating condition, taking all data simultaneously on an average-temperature day. The condensate temperature is known.

The heating system condensate may be metered or it may be weighed for several intervals under as near average conditions as possible. The weight of low-pressure steam that is condensed in the feed-water heater is unknown, although the heat content per pound is known.

Development of Formulas

Having determined the temperatures of condensate and feed water, the following formula* is set up, assuming a 95 per cent feed-water heat transfer efficiency:

$$H = 0.95\ (H_f + H_l + H_c + H_s)$$

As most steam tables are for heats above 32 deg. F., the formula will be set up on this basis.

Heat in cold-water feed:

$$H_f = Q_f(T_f - 32)$$

Heat in low-pressure steam at 3 lb. pressure:

$H_l = Q_l\ (h_l)$, where h_l is the heat in one pound low-pressure steam.

Heat in condensate from prime movers:

$$H_c = Q_c\ (T_c - 32)$$

Heat in condensate from heating system:

$$H_s = Q_s\ (T_s - 32)$$

So, since total heat $H = 0.95\ (H_f + H_l + H_c + H_s)$, we have:

(1) $H = 0.95\ [Q_f(T_f - 32) + Q_l(h_l) + Q_c(T_c - 32) + Q_s(T_s - 32)]$

and total weight:

(2) $Q = Q_f + Q_l + Q_c + Q_s$

Consider that in formula (1), Q_f, the weight of makeup water, and Q_l, the weight of low pressure steam, are the only two items unknown. Likewise, in formula (2), Q_f and Q_l are the only unknowns. Therefore the two formulas may be solved simultaneously.

Solution of a Typical Problem

The solution for a typical example is as follows, data being assumed for a medium sized industrial station. The solution will show the makeup water requirements and the low-pressure steam requirements for feed heating:

Low-pressure steam at 3 lb.,....h_l =1,130 B.t.u. per pound.

Q_l is unknown.

T_f equals 60 deg. F.

H_f equals $Q_f(60 - 32)$

Q_f equals unknown makeup water required per hour.

$T_c = 140$ deg. F.

$Q_c = 1{,}200$ lb. per hr.

$H_c = 12{,}000(140 - 32)$ equals 1,296,000 B.t.u.

$T_s = 160$ deg. F.

$Q_s = 10{,}000$ lb. per hr.

$H_s = 10{,}000(160 - 32)$ equals 1,280,000 B.t.u.

$T = 222$ deg. F.

$Q = 50{,}000$ lb. per hr.

$H = 50{,}000(222 - 32) = 9{,}500{,}000$ B.t.u. per hour.

Substituting in formula (1),

$9{,}500{,}000 = 0.95(28Q_f + 1{,}130\ Q_l + 1{,}296{,}000 + 1{,}280{,}000)$

Collecting and combining we have

$28Q_f + 1{,}130Q_l = 7{,}424{,}000$

(3)...$Q_f + 40.3Q_l = 265{,}000$.

Substituting in equation (2) $50{,}000 = Q_f + Q_l + 12{,}000 + 10{,}000$

Collecting

(4)...$Q_f = 28{,}000 - Q_l$

Combining (3) and (4)

$Q_l = 6{,}030$ lb. per hour of low-pressure steam entering feed-water heater and $Q_f = 21{,}970$ lb. per hour = makeup water required per hour.

Comparing Methods of Operation

Calculated values as a result of spot readings are not as reliable as values calculated from meter readings over a period. However, they give a good indication of what water condition actually exists when any two items contributing to the total flow to the boilers are unknown. If the makeup water is known and the heating system condensate is the only unknown quantity, except the low-pressure steam for heating the feed water, the amount of heating-system condensate may be calculated. Occasionally checks of heating system condensate may be desirable to determine just what the heating system demand may be on days when the demand is heavy.

Another instance of the use of the formulas lies in the consideration of purchased power. If a particularly favorable power rate is available for use for the entire power requirements throughout a year the heating system requirement becomes important in comparing the generation power of steam alone or and of steam plus power.

The feed-water heater does not under some conditions make much better use of exhaust steam than the heating system. However, hot feed water is desirable from the viewpoint of elimination of oxygen corrosion, unstable steaming conditions in the boiler and leaks due to temperature differences between pipe connections and boilers.

The difference in the actual heat balance if the condensate from a heating system is returned to boilers is very small and is only equal to the return line heat loss. If the condensate is not returned the loss is considerably larger, amounting to 1,000,000 B.t.u. per hour above 60 deg. F., in the example chosen in addition to the value of the salt-free water itself.

Even if high-pressure steam must be used occasionally for boosting the low-pressure heating system it is good practice to continue using the feed heater because of its efficient heat transfer; little heat is lost and better boiler operation is possible.

If the question arises whether a low-pressure turbine can utilize steam to a better degree than a feed heater the economics may be checked by determining how much power the low-pressure steam entering the feed heater could otherwise generate. It will be found that the feed heater uses heat from low-pressure steam to a much better degree than the mixed pressure turbine.

In the example taken, with a mixed-pressure turbine using 3 lb. of low-pressure steam to replace one pound of high pressure steam, it is found that with $4.00 coal the feed heater will show earnings of about $10.00 per day in decreased coal consumption.

In applying steam to a feed heater considerable waste of heat is possible if a vent is kept wide open and an excessive amount of steam escapes to the atmosphere. The use of a condenser on the air vent will of course eliminate this waste and is quite desirable not only from the viewpoint of waste but from the angle of appearance. It is worth something to keep "feathers" of steam from wasting as it produces a bad example and is a reflection to some extent on the power engineer.

The feed heater is probably the most efficient piece of equipment in a boiler room or a power plant, yet, as a rule, little definite information is developed regarding its operation, the quantity of steam it requires, and how much water from each of the many sources actually enters the heater.

A thorough understanding of the thermal demands of an industrial plant is made possible by including the feed-heater demands because of its relation to heating system steam requirements which are difficult to meter.

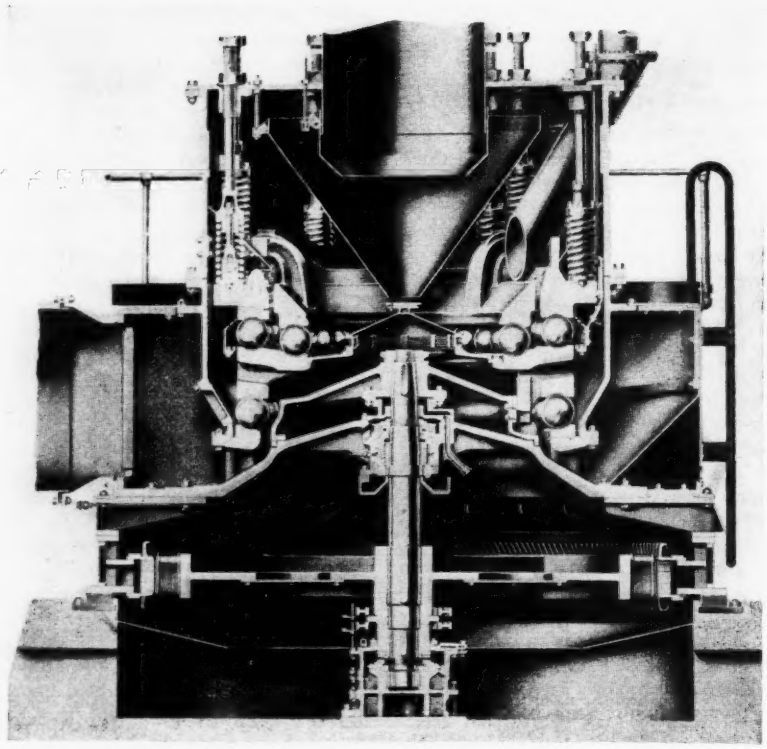
In the example chosen over 10 per cent of the total steam generated returned to the feed heater, and of the total of 15,150 lb. of low-pressure steam two-thirds was used for heating system and one-third for feed heating. Knowledge of the feed water heater aids in the planning of future power plant developments and is of value in the study of the heat balance.

Steels for High Temperatures

"Ever since the finish of the war there has been an insistent demand for greater economy in the production of power and at the present time it is being accentuated by world-wide economic depression. The only way in which this demand can be satisfied is by increasing the pressure and temperature at which steam is used. Boiler makers have consequently been driven to construct boilers for pressures that only a few years ago would have been regarded as fantastic and the temperatures of superheated steam have now reached the limits imposed by existing known materials.

"These advances in boiler practice have, as was only to be expected, brought a crop of problems in their train.

"Methods of steel testing, also grow more and more complicated; new factors have to be introduced and measured. It is becoming increasingly necessary, yet at the same time increasingly difficult, to test materials under the actual conditions under which they have to work. The time-honored method of breaking test pieces at atmospheric temperature, in which no account was taken of the rate at which the load was applied, although still having a wide field of utility, is hopelessly inadequate to give the information necessary nowadays for modern high-pressure and high-temperature requirements."—From report of V. B. Harley-Mason, Engineer in Chief of Manchester Steam Users Assn.



Cross-section of vertical 51-ton pulverizer with direct-connected synchronous motor

High-Capacity Coal Pulverizers At Kips Bay Station*

By PERRY CASSIDY

KIPS BAY station, of the New York Steam Corporation, was completed and placed in service in December, 1926 with a total capacity of 975,000 lb. of steam per hour at 300-lb. pressure. A fourth unit was added in 1927, bringing the total capacity of the station up to 1,300,000 lb. of steam per hour. The rapid increase in the demand for central-station steam in 1928 and 1929 made it necessary, early in 1930, to consider the installation of another steam-generating unit and additional pulverizing equipment. At that time there remained only one unoccupied bay in the boiler room and two in the mill house. This paper describes the coal-preparation plant extension and gives some of the results obtained during the first operation of the new mills.

The plant was originally designed to burn pulverized coal using the bin system and the location of the mill house and the raw-coal handling equipment made it advisable to continue with future installations on this same basis.

The increased capacity necessitated by the 1930 extension in the boiler room could just barely be taken care of by one new mill of approximately 25 tons capacity, but after this was installed only one bay would remain for future extension. Space for two more 25-ton mills could be provided at the north end by building alterations, but this would not have given enough mill capacity for the ultimate boiler installation. A decision was therefore made to purchase one mill of 25 tons per hour capacity to take care of the current capacity demand and to install in the remaining bay the largest mill available, that would best meet the requirements of system layout, operating reliability, low maintenance, low power consumption and uniformity of product.

Beside the usual problems inherent in the design of the pulverizer itself, the manufacturer's engineers had further limitations imposed on them by existing building column spacing and floor elevations that could not be changed. The first of these requirements made it necessary to pulverize a considerably greater quantity of coal per square foot of floor area occupied by the pulverizer than was customary up to that time, while the second limited the permissible height of the unit.

The new pulverizing installation, units 6 and 7, consists of two Fuller Lehigh type B mills with auxiliary equipment, now rated at 51 and 30 tons per hour respectively for coal of 80 grindability or better.

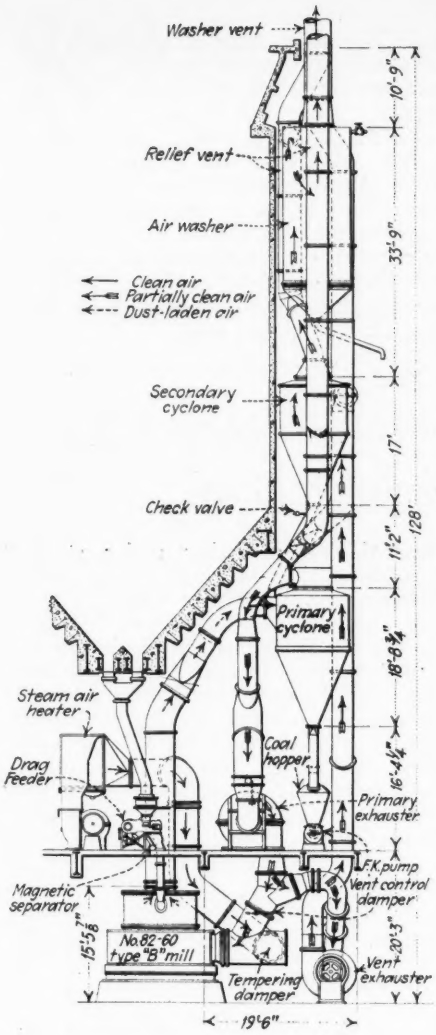
Coal is supplied to each mill by two drag feeders with magnetic separators leading to feed spouts on opposite sides. Both mills are of the air-separation type. Coal-ladened air leaves from the top of the mill and goes to the primary cyclone where the coal is discharged into the hopper of a transport pump which conveys the coal to the pulverized-coal bins over the boilers.

Primary air to the mill is heated by a steam-air heater. The hot-air inlet to the mill is supplied with a cold-air tempering connection controlled by a butterfly damper. The discharge from the primary exhauster is connected to the mill air inlet at the same point and through a Y-connection to the vent exhauster. The arrangement of both units is the same with the exception that the 51-ton mill has two primary cyclones, two secondary cyclones, and two air washers on account of space limitations between the coal bunker and the building wall.

The 51-ton mill is the first type B mill to be supplied with a third inner row of grinding balls.* This third row of balls has an independent upper grinding ring, spider, and spring system. Coal from the feed spout drops on to the rotating table attached to the intermediate grinding ring. The centrifugal action of the table throws the coal into the inner row of balls where the first stage of pulverization takes place. From the inner row of balls the coal passes to the outer row, where the second stage of pulverization is effected. Coal is retained in this outer row by the perforated annular basket outside the intermediate and top grinding ring. Tramp iron which may escape the magnet is retained in this basket. When the coal is reduced fine enough to pass the adjustable ledge gap between the intermediate grinding ring

	Unit 6. 51-Ton Mill			Unit 7. 30-Ton Mill		
	Expected Performance	Test Results		Expected Performance	Test Results	
Grindability of coal	65	62	76	65	63	76
Mill capacity, tons per hr.	40	44	54	25	28.8	30.6
Mill kw.-hr per ton	9.5	10.3	9.5	10.0	7.8	7.35
Exhauster kw.-hr. per ton	5.0	3.6	2.9	4.5	3.0	2.7
Feeder kw.-hr. per ton	0.2	0.08	0.08	0.2	0.099	0.08
Total kw.-hr. per ton	14.7	13.98	12.48	14.7	10.89	10.13
Total air from mill, cu.ft. per min.	....	22,000	22,500	....	16,900	15,820
Total air from mill, cu.ft. per lb. coal	....	15.0	12.5	....	17.5	15.5

*Abstract of paper presented before Metropolitan Section, A.S.M.E., Feb. 1.



Side elevation of 51-ton mill and equipment

and the basket, it falls to the space outside the lower row of balls and thence into the third stage of pulverization. The hot primary air passes through the ports beneath the lower grinding ring and upwardly past the inside of the lower row of balls where it picks up the pulverized coal discharged from the third stage. Most of this coal and air pass outwardly through ports in the intermediate grinding ring, the remainder bypassing through the cylindrical screen is directed against the inner row of balls where the hot air mixes with the raw coal from the feed spouts. The coal and air leaving the ports in the intermediate grinding ring pass upward around the perforated coal basket. Some of the hot air passes through the perforations in the top of the coal basket between the outer row of balls and up into the top section. The main stream of coal and air is deflected by the sloping conical baffle and is directed downward toward the center of the mill. The three streams of coal and air unite and pass over and into the conical separator and out the top of the mill.

There are 19 balls in the inner row, and 27 balls in each of the outer rows. All balls are 9¼ in. in diameter. The diameter of the ball circle in the inner row is 60 in. and in the outer rows 82 in. The intermediate grinding ring revolves at a speed of 72 r.p.m. and the balls at a speed of about 36 r.p.m. The main shaft of the mill is attached directly to the rotor of a 500 hp. 72 r.p.m. 2,300 volt, 3 phase G.E. vertical synchronous motor. The structural parts of the stator and motor are made of heavy fabricated steel welded and braced to withstand both direct and vibrational strains.

The expected performance for units 6 and 7 were based upon pulverizing Pittsburgh coal, crushed to pass through a ¾-in. ring. Moisture to be not over 6 per cent with coal having a grindability of 65 or better provided that preheated air at 400 deg. is available for use in the mill.

The expected performance of mill No. 6 was 40 tons per hour with a fineness of 70 per cent through the 200 mesh and 98 per cent through the 40 mesh. The expected power consumption was 9.5 kw.-hr. per ton for the mill, 5.0 kw.-hr. per ton for the exhauster and 0.2 kw.-hr. per ton for the feeders, or a total of 14.7 kw.-hr. per ton.

Under the same conditions, the expected performance for mill No. 7 was 25 tons per hour. with a power consumption of 10.0 kw.-hr. per ton for the mill, 4.5 kw.-hr. per ton for the exhauster, and 0.2 kw.-hr. per ton for the feeders, or a total of 14.7 kw.-hr. per ton. The expected maintenance material cost of both mills is not over 2 cents per ton.

A large number of tests were run on both mills for experimental data prior to the acceptance tests. The acceptance tests demonstrated conclusively that both mills met all requirements with an ample margin. The results of two of the tests on each mill are given in the table for low- and high-grindability coal. In all of these tests the fineness of the pulverized coal complied with the specification of 70 per cent through the 200 mesh and 98 per cent through the 40 mesh.

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High-Pressure Residues as Boiler Oil*

By T. P. STILLMAN

CERTAIN PLANTS using Bunker *C* boiler oil obtained from high-pressure cracking stills have experienced trouble from carbon formation at the burner tip and from slagging of the fire brick. As far as known these troubles have been confined to plants equipped with burners of the mechanical-atomizing type, and there have been no cases where exceptional difficulty has been experienced with steam-atomizing burners using similar fuel.

In order that all may understand just what Bunker *C* fuel oil is, the following is quoted from the definition of the Federal Specifications Board for this grade of oil:

> "It shall be a hydrocarbon oil free from grit, acid, and fibrous or other foreign matters likely to clog or injure the burner or valves.
> (a) Flash Point, minimum by the Pensky-Martens closed cup tester, 150 deg. F.
> (b) Water and Sediment, maximum 2.0 per cent
> (c) Viscosity, Saybolt Furol at 122 deg. F., maximum 200 seconds."

The only difference between Bunker *A*, *B* and *C* fuel oil is the viscosity permitted at certain temperatures, and the percentages of non-petroleum impurities allowed. It is important to note that there is no mention made in the specifications of the gravity of the fuel oil that may be sold under the classes.

Several years ago the author's attention was called to a Bunker *C* fuel oil which showed unusual operating characteristics. The chief engineer of one of the downtown New York City office buildings who had been burning Bunker *C* fuel oil of the 14 to 16 deg. Baumé type for a number of years, was offered some appreciably cheaper but heavier fuel oil. As he knew his pumping and heating set was good for oil temperatures of well over 300 deg. F., he decided to try a shipment of it in view of the savings indicated.

Shortly after he started to use this heavier oil he found that the atomizers were plugging so rapidly with what looked like carbon deposit, that he was having difficulty in holding steam. He was carrying approximately 325 deg. F. on the oil in accordance with the table of proper temperature to use with given Baumé oils which he had employed as a guide for years. The producers of the oil were called in and it was learned that the viscosity of this particular shipment bore no relation whatever to its gravity, and that with a 175-deg. F. temperature, a proper viscosity for satisfactory atomization would be secured. The temperature of the oil was promptly reduced to this figure, the spare oil heater cut in, as it was found the pressure drop through the other was becoming very excessive, and the atomizers thoroughly cleaned once more. No further difficulty was had. Investigations of the oil heater showed that it was plugged almost solid with carbon deposit adhering to the inside of the tubes. The oil producers advised that the oil they were supplying contained a large percentage of residue from their high-pressure cracking stills.

One of the large steamship lines

*Abstract of paper presented at a meeting of the Metropolitan Section, New York, N. Y., January 28, 1932, of The American Society of Mechanical Engineers.

operating on the West Coast was offered some fuel oil at a lower price than the oil they were using, and were advised before they bought it that it contained cracked residues, and to be guided by viscosity in handling, which they did. As far as the author knows they had no trouble with heaters or atomizers plugging, and the combustion results secured were satisfactory. A short time after starting to use this fuel, however, it was noticed that the brickwork of the furnaces was slagging to an unusual and alarming extent. Investigation revealed the fact that the oil before being placed in the cracking stills had been treated with lime. The excess of this lime had appeared in the residue from the cracking process, and in the fuel oil given the ship. As the increased expense in furnace up-keep with this residue was appreciably greater than the saving in fuel cost its use entailed, the ship owners stopped using the cracked residue mixture and went back to straight fuel oil.

Another ship on the West Coast took some cracked residue fuel oil aboard at Los Angeles for the run to San Francisco. Experts of the oil company were aboard to assist in the operation and to insure that the new fuel was properly handled. Shorty after leaving Los Angeles difficulty was experienced from excessive plugging of strainers and atomizers, this continuing to such an extent that in spite of the most active efforts by the crew, difficulty was experienced in having the ship meet her schedule. The representatives of the oil company stated that the trouble was due to loading the new residue oil into the fuel-oil tanks without first cleaning them of the sludge remaining from the old fuel oil. This had the effect of stirring up and floating the old sludge through the new oil, with results outlined. Further inquiry also revealed that the new oil had been put aboard without any filtering, and that it contained a large percentage of flocculent carbon. In all probability the troublesome results secured were due to a combination of the two evils.

One of the characteristics of these cracked-oil residues appears to be their ability to continue to form flocculent carbon particles even when they are stored at relatively moderate temperatures. An increase in temperature radically increases this action, and indications are that it continues after the oil is discharged into the furnace, producing an effect upon the combustion similar to burning of pulverized coal. One of the oil companies that operates a large fleet of tankers fitted with Scotch boilers has been experimenting with the burning of cracked residues in these boilers. To obtain as efficient combustion results in these relatively cold Scotch furnaces with the cracked residues as they had with the older fuel oils they had been using, it was found necessary to install refractory-lined extensions in the front part of the furnaces. In this way the average furnace temperature was increased sufficiently so that in burning the carbon-particle bearing-cracked residues, the combustion was as complete with the limited furnace volume available, as had been the case with the original fuel oil without the refractory extension.

It is well to keep in mind that fuel oils containing these cracked residues are inherently excellent fuels for power purposes, being high in heat value per gallon and should command as high a price as the older styles of Bunker *C* fuel oils. In spite of their relatively great density, their viscosity is low compared to the uncracked heavy grades of fuel oil, requiring less live steam for heating per gallon of oil burned. The most important point of all is that the percentage of cracked residues available for fuel oil is steadily rising and the supply of fuel oils from low-pressure stills is steadily decreasing. It would be well to modify fuel-oil specifications to more clearly identify them, and at the same time, in the preparation of these residues for the fuel-oil market, treat them so that the operators need anticipate no more difficulties in handling and burning them than they do with the old-time Bunker *C* fuel oils.

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Bureau of Mines Reports on Flow of Natural Gas Through High-Pressure Transmission Lines

PRACTICAL FACTS for the use of operators in designing high-pressure natural-gas transmission lines and for determining the effects of different operating conditions on pipe-line capacities have been made available by the United States Bureau of Mines in a recent report on factors influencing flow of natural gas through these lines. In cooperation with the natural gas department of the American Gas Association, the Bureau of Mines has been studying actively for the past several years the problem of the flow of natural gas through high-pressure transmission lines. Numerous data on gas flow through pipe lines under many conditions of operation have been obtained by carefully conducted tests, and these data, together with all other available information, have been analyzed carefully.

Flow tests have been made on 29 different pipe lines, totaling 757 miles of pipe, and located in the principal natural-gas areas of the country. The diameters of the pipe lines tested range from 6 to 22 in. and the operating pressures from 30 to 600 lb. per sq.in.

The nature of the investigation was primarily an engineering study of pipe lines used in the long-distance transmission of natural gas and a comparison of the actual observed rates of flow with the results obtained from the application of the various pipe line flow formulas.

The report includes a comparison and discussion of the common pipe line flow formulas, the factors which determined the selection of pipe lines for study, the method of conducting the field tests, and comparisons between the measured deliveries and those calculated from the pipe line flow formulas. A discussion of representative pipe line free from condensates, rust scale, or similar obstructions is emphasized with results from tests under such conditions.

A feature of the report is the listing of the important results of the experimental tests on all of the pipe lines that were tested in one comprehensive table.

The results of the experimental tests made in the investigation show that Weymouth's pipe-line flow formula, when applied to the larger-diameter lines free from condensates and other foreign material and operating under steady flow conditions favorable to accurate measurement, will give a volume within a few per cent of the measured delivery.

Complete details of the results of the study are given in Report of Investigations 3153, "Factors Influencing Flow of Natural Gas Through High-Pressure Transmission Lines," by W. B. Berwald and T. W. Johnson. Copies of the report may be obtained from the United States Bureau of Mines, Washington, D. C.

Large B.C. Hydro Reserves Usable, Engineers Report

NEW POTENTIAL SOURCES of hydro-electric power totalling millions of horsepower have now been proven to exist in British Columbia. Previously the known potential and developed horsepower of electrical energy in that province was approximately 2,000,000. Now a number of new reserves have been revealed, some of which alone would more than double the previously known figures. This was revealed recently before the Victoria Branch of the Engineering Institute of Canada by F. W. Knewstubb, S. H. Frame, and R. C. Farrow, engineers of the waters rights department of the provincial government.

These new reserves are located in the chain of lakes and river headwaters immediately east of the coast range of mountains. It is claimed by engineers who have been surveying the areas for twenty years, that it has now been found feasible to tunnel through this mountain range for lengths varying from nine to ten miles and provide heads of water up to 3,000 ft. for tidewater power plants on the northern coast.

One scheme calls for development of the waters in the Chiko Lake and Homathko River by boring a tunnel nine and a half miles to create a 3,000-ft. head of water for operation of a power plant at Dean Channel, developing 1,430,000 hp. At a more northern point on the mainland coast a bore of ten miles would develop 2,500,000 hp.

WHAT'S NEW IN PLANT EQUIPMENT

Bypass Relief Regulator for Pressure Control Valve

To SAFEGUARD the actuating element of a pressure control valve against excessive unbalanced pressures the two-way relief illustrated has been developed by the Northern Equipment Company, Erie, Pa. These unbalanced pressures may be brought about by water hammer, or may be encountered when bringing a high-pressure boiler up to operating pressure. The two-way relief valve is installed between the high (steam) and low (water) connections to the pressure control valve as shown in the illustration.

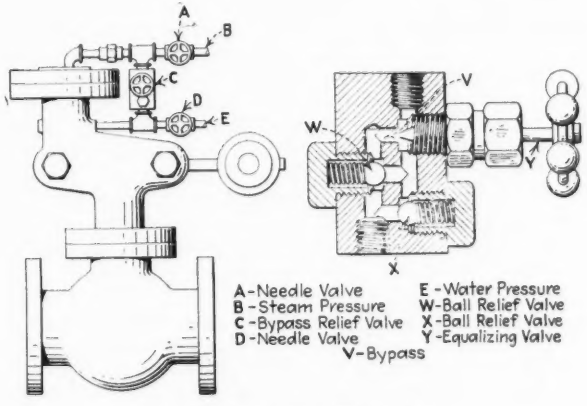
Referring to the cross-section, the springs holding balls "W" and "X" are set for a maximum differential pressure of 200 lb. In normal operation, the equalizing needle valve "Y" is closed, shutting off passage "V."

Should the steam pressure become more than 200 lb. greater than the water pressure, ball "W" is moved from its seat permitting sufficient water to flow through the opening to stabilize the pressure differential at 200 lb.

Likewise if the water pressure becomes more than 200 lb. greater than the steam pressure, the excessive pressure is relieved by moving ball "X" from its seat until the pressure differential is stabilized at 200 lb. Thus, the actuating element of the pressure control valve is protected.

Valve "Y" is simply a hand-operated needle valve provided to equalize the pressures when the pressure control valve is cut out of service. This is done by opening valve "Y" and thus opening passage "V."

Needle valves A and C are used to throttle the pressures in the steam and water connections, thus preventing "hunting" caused by rapid pressure fluctuations.

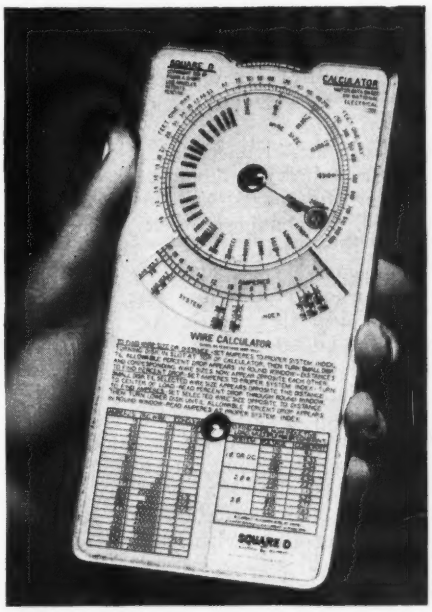


Two-way relief valve

Calculator for Wiring and Motor Data

A WIRING and motor data calculator of unusual design is announced by the Square D Company, 6060 Rivard St., Detroit, Mich. The calculator is compact in size, 7 in. long, by 3½ in. wide by ¼ in. thick, and can be easily carried in the pocket.

There are essentially two calculators,



Square D calculator

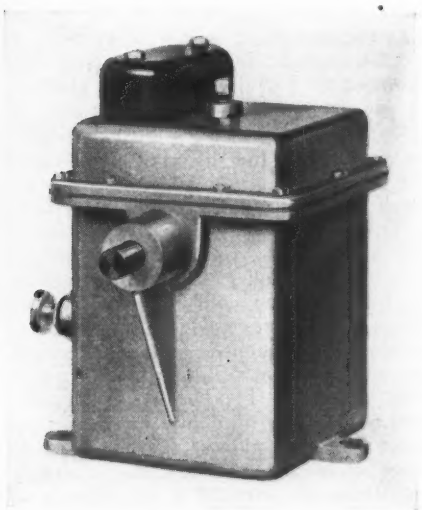
one for computing wiring data and the other for computing motor data. The figures are distinct and legible and they are protected by a water-proof celluloid covering. The wiring calculator for interior and conduit wiring problems will figure any one of the four items—amperes, feet of wire, size of wire, and per cent drop. The dials are easily set and the reading is automatically given.

The motor calculator gives data on the three principal types of 220-volt and 440-volt 3-phase motors. Each type is represented by a colored section of disk. Using the proper disk segment, set for horsepower, the following data can be read—circuit switch starting fuse, conduit size, wire size, necessary running protection and full load amperes.

Each calculator is supplied with a carrying case and complete instructions.

Adjustable-Speed Damper Controllers

DAMPER CONTROLLERS made by the Barber-Colman Company, Rockford, Ill., may now be obtained with speed-regulating governors for use with both single- and multiple-louvred dampers in heating, ventilating and air-conditioning systems. If the temperature changes slowly at the point of thermostatic contral (in a large room, for example), the damper controller can be set to operate slowly so that the damper floats between an open and a closed position. If the thermostat is located in front of a ventilating fan, on the other hand, where rapid temperature changes are



Barber-Colman damper controller

encountered, the damper controller can be set to operate at a much faster speed. The regulating governor is simple in design, and allows a wide speed range.

In effect, the governor is a small reciprocating pump working against a variable head set up by the pressure necessary to force oil past an orifice at one end of the pump cylinder. Variation in speed is obtained by adjusting this opening with a screw extending through the controller case.

A fractional-horsepower induction motor of the shaded-pole type actuates the controller and its governor. This motor is designed with ample power and high starting torque, so that when properly cooled it may be run indefinitely under any conditions between no load and stalling load.

NEWS of the FIELD

Live Topics and Discussion Feature First Convention of Pacific Coast N.A.P.R.E. Chapters

THE FIRST convention of the Pacific Coast Chapters of the National Association of Practical Refrigerating Engineers, held in San Francisco, Feb. 17-18, was attended by over 140 delegates from Seattle to San Diego. Up-to-the-minute topics enlivened the sessions, which were marked by an unusual willingness to contribute to the discussions that followed presentation of formal papers.

On Wednesday morning the session was devoted to the subject of car icing plants. Two methods were discussed at length, first, the method using drag-chain and skid platform to the bunkers. Details of the proper handling of this type of icing plant were explained by LeRoy Etzel and J. F. Daly. The second method, discussed E. T. Quinn, was the overhead monorail system.

Wednesday afternoon was given over to the subject of quick-freezing methods of preserving foodstuffs. Prof. M. A. Joslyn, University of California, gave an account of the different methods in use, and their application to different food products and some of the problems involved in handling frozen foods. His address was followed by a discussion led by Frank Hibbs on the freezing of foods by the cold-air blast system. Wetmore Hodges told of practical experiences in the processes of freezing, transporting and selling of these products. Harry T. Holbrook detailed methods of checking and analyzing ice manufacturing plants, showing how a plant may be checked to maintain maximum production at all periods of its natural life. N. H. Rosberg's discussion brought out the importance of carefully maintained cost accounting in all plants.

The annual safety conference on Wednesday evening was one of the highlights of the convention. Plant engineers in California were complimented by W. A. Chowen, who stated that the refrigerating industry in the state was one of two industries who would receive this year a reduction in compensation insurance rates.

On Thursday morning, following a brief talk on the history and origination of the association given by Harry T. Whyte, a talk on corrosion control was given by H. L. Lincoln. He displayed charts showing the various stages of corrosion on the ice cans in the ice-freezing tanks and told of the useful application of the chromium treatment in retarding the corrosion. Further discussion of the use of chromium treatment was given by L. I. Denton and the care of the ice cans and the ice-freezing tanks was given by R. L. Benson.

The remainder of Thursday morning was given over to a series of articles and general discussion on the topic of Space or Comfort Cooling With Ice." A paper was presented on this subject by H. N. Royden, which included several charts showing the estimated cost of installation and cost of operation of plants in actual operation. He pointed out the following advantages of using ice for this purpose: No engineer is needed, no condenser or circulation of water is needed. It is a safe method, no expensive equipment is needed, and it has a lower operating cost.

A typical air-conditioning installation was explained by W. H. Park, and H. T. Holbrook gave a talk illustrated with charts showing the small-store application. The use of a similar system in a Los Angeles restaurant was explained by Donald DeFremery. A fifth paper was read on this subject reviewing the possibilities in space and comfort cooling with ice and urging the practical refrigerating engineer to become familiar with their job in developing and installing such systems because the development of this industry depends a great deal upon the intelligent work these men do in their localities.

At the business session held Thursday afternoon it was decided to hold a similar meeting next year and was suggested it be held in southern California.

Diesel Units Installed for Carlsbad Caverns Elevator

Two 120-HP. diesel-engine-generators have been installed to operate an electric elevator in the Carlsbad Caverns in New Mexico. It is planned to add another 240-hp. diesel unit to this equipment later.

Lifting machinery and elevator are of latest design, gearless, high-speed, fully automatic with all safety features. The elevator has a speed of 700 ft. per minute, with a capacity of 2,000 lb. or twelve persons. The cage is held by six cables, each being strong enough to carry the cage and load. The cage may be controlled by devices in the building at the surface as well as by the operator; it is balanced by counterweights heavier than the cage itself, so that the empty cage has a tendency to rise instead of drop. Besides using a minimum of motive power, this feature provides additional safety. Telephone communication from the cage is possible at all elevations.

The shaft, elevator and equipment were installed at a cost of approximately $91,000. Built to accommodate two elevators, the shaft measures 8x16 ft. and is 754 ft. deep. The entire shaft, built through solid rock, is lined with gunite concrete.

Utility Commissions Favor Bill to Limit Court Powers

STATE COMMISSIONS engaged in the regulation of public utilities are generally favorable to the proposed federal legislation embodied in Senator Johnson's bill to restrict the jurisdiction of Federal district courts, according to a statement issued by Charles M. Thomas, Public Utilities Commissioner of Oregon.

Senator Johnson's bill would take jurisdiction from the lower federal courts, where jurisdiction is based solely upon the ground of diversity of citizenship or the repugnance of the commission's order to the Federal Constitution, and where an efficient remedy is available in the state courts.

Mr. Thomas disclosed that he has circularized the State commissions on the matter, and the replies, he said, have "developed an amazing situation in that it appears to be practically agreed among the commissions that regulation cannot continue unless the proposed legislation is procured."

Agreement with the proposed legislation was expressed by commissioners representing the states of Montana, New Mexico, Oklahoma, Texas, Wyoming, Alabama, Arizona, Georgia, Wisconsin, California, New York (Transit Commission), New Hampshire, Nevada and Maine. A letter from Iowa stated that the matter has been referred to John E. Benton, of Washington, D. C., general solicitor of the National Association of Railroad and Utilities Commissioners. Mr. Benton expressed his opinion as follows:

"I do not think the federal courts should step into a state and interfere with state action upon the ground of confiscation until it has been demonstrated that the state will confiscate if not thus interfered with. When a state

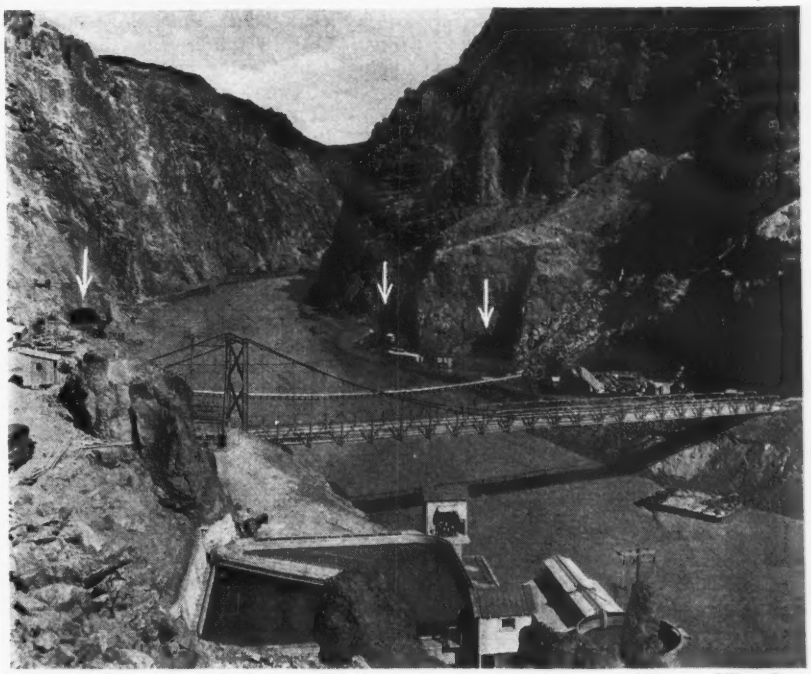
has by its laws provided judicial protection through the tribunals of the state against any ill-considered or inadvertent action which amounts to confiscation, the state through its own courts should be permitted to extend the intended protection."

Symbols for Mechanics and Materials Adopted by A.S.A.

SYMBOLS for mechanics, structural engineering, and testing materials have been approved by the American Standards Association as an American Standard. The standard consists of letter symbols for 69 quanties commonly used in these fields.

These symbols were prepared by Subcommittee 1 on Mechanics, Structural Engineering, and Testing Materials of the Sectional Committee on Scientific and Engineering Symbols and Abbreviations. The sectional committee is under the sponsorship of the American Association for the Advancement of Science, the American Institute of Electrical Engineers, the American Society of Civil Engineers, the American Society of Mechanical Engineers, and the Society for the Promotion of Engineering Education.

RAPID PROGRESS MADE AT HOOVER DAM



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With work six months ahead of schedule, rapid headway is being made on the construction of Hoover Dam. The picture, taken shortly before the recent flood, shows the site of the dam from the downstream side. Arrows indicate the outlets of three of the four diversion tunnels, and the settling basin, where water for Boulder City is clarified, is shown in the lower right-hand corner. The dam and main power house will be erected approximately at the point where the river disappears behind the cliff

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Boiler Tests Feature of Rochester (Minn.) Power Show

LARGE ATTENDANCE and active interest in the many features offered marked the three-day convention and power show of the Minnesota League of Municipal Electrical Utilities held at Rochester, Minn., Feb. 24 to 26.

Nearly 800 engineers and city officials from towns and villages in ten states registered at the convention, large numbers attending each of the various sessions held on engineering and municipal-ownership topics. The states of Minnesota, Wisconsin, North and South Dakota and Michigan furnished the majority of the registrants.

Natural gas and the gas-coal comparative tests carried on at the City Light Plant were, by far, the most interesting subjects to those attending.

Northern Gas & Pipe-Line Company has recently extended a branch of its line as far as the City of Rochester. The company's main line, extending across the states of Kansas, Nebraska and Iowa, has at present, progressed as far as the south-central portions of Minnesota. This fuel has been in use since the middle of January under the boilers of the Franklin Heating Station, which supplies power, steam at two pressures, and hot and cold water to the various buildings of the Mayo Clinic-Kahler Corporation.

Natural gas burners have recently been installed under one boiler in the City Light Plant for a trial operation period of one year. The comparative tests made at meeting were a part of this trial. Final results of the test will be available as soon as complete data is worked up.

Engineers and officials of both the gas company and coal companies were present in full force, each anxious to point out the merits of his particular fuel. A considerable portion of the league's sessions was given over to discussion of the relative merits of natural gas and coal.

P. G. & E. to Rebuild Potter Valley Plant

PLANS FOR the reconstruction of its Potter Valley power house about fifteen miles northeast of Ukiah, Calif., have been announced by the Pacific Gas & Electric Company. Work, which is scheduled for the early part of this summer, will give employment to approximately 200 men for a period of six months. Plans call for installation of an 8,500-hp. hydraulic turbine and a new generator to replace two 2,500-hp. generators designed 23 years ago, and the rearrangement of the interior layout. At present the plant is equipped with four electric generators and has an installed capacity of 12,750 hp. Installation of modern equipment will bring the installed capacity up to 16,750 hp. With the same volume of water passing through the new generating equipment efficiency of the plant will be increased from 46 to 86 per cent.

Valve Dimension Standard Released for Criticism

A PROPOSED American Standard giving center-to-face dimensions for three kinds of ferrous-flanged valves—wedge-gate, globe, and angle valves—has been released for general criticism and comment and may be borrowed from the American Standards Association, 29 West 39th Street, New York, N. Y., by any one interested.

The proposed standard covers wedge-gate valves in sizes from 1 to 24 in. outside diameters (cast-iron for 125 and 250 lb. steam pressure, and steel for steam pressures of 150, 300, 400, 600, 900, and 1,500 lb.); and globe and angle valves in sizes from ½ to 8 in. (cast-iron for 250 lb. steam pressure, and steel for steam pressures of 300, 400, 600, 900, and 1,500 lb.).

The draft was submitted in the fall of 1931 to Subcommittee 5 on Face-to-Face Dimensions of Ferrous Flanged Valves of the Sectional Committee on Pipe Flanges and Fittings. It was developed by the Manufacturers Standardization Society of the Valve and Fittings Industry and was adopted to become effective, in so far as its members are concerned, on July 1, 1932. The subcommittee, after considering the draft, decided to have it distributed for general criticism and comment and it has thus been released for this purpose to all interested engineers, designers and manufacturers. Pertinent suggestions will be welcomed by the subcommittee.

F. L. Hutchinson Dies; Secretary of A.I.E.E.

FREDERICK LANE HUTCHINSON, national secretary and executive manager of the American Institute of Electrical Engineers, died Feb. 26 at the Homeopathic Hospital in East Orange, N. J., of heart disease following a brief attack of pneumonia. He was born in Elizabeth, N. J., April 2, 1866.

Following graduation from Cornell University in 1893, Mr. Hutchinson entered the employ of the Westinghouse

Electric & Manufacturing Company. After several years' experience in the manufacturing, testing, engineering and sales departments in Newark, N. J., and Pittsburgh he became manager of the publication department of the C. W. Hunt Company, New York, and one year later advertising manager of the National Electric Company of Milwaukee, subsequently becoming its electrical sales manager.

In 1904 Mr. Hutchinson came back to New York City and undertook special work on the *Transactions* of the A.I.E.E.. In 1908 he became assistant secretary and in 1911 acting secretary. On Jan. 12, 1912, he was appointed national secretary.

Mr. Hutchinson had become an associate of the institute in 1894 and a member in 1913. His work as national secretary, which won high praise, took him to London in 1924 as a delegate of the institute to the World Power Conference and to Tokyo in 1929 as a delegate to the World Engineering Congress.

1931 Hydro Installations In Canada Total 541,325 H.P.

ANNUAL STOCK-TAKING of Canada's power resources shows that the recorded water powers will permit turbine installations totalling 43,700,000 hp., according to Bulletin No. 1573 just issued by the Dominion Water Power and Hydrometric Bureau. To date the actual installation in water wheels and turbines reaches a total of 6,666,337 hp., of which 541,325 hp. was installed during 1931. Canada has therefore developed her water powers to the extent of approximately 15½ per cent of the recorded resources.

At the present time there are 328 hydro-electric central stations with a total installation of 5,734,491 horsepower.

COMING CONVENTIONS

American Society of Mechanical Engineers. Spring meeting at Bigwin Inn, Lake of Bays, Ont., Canada, June 27-July 1. Oil and Gas Power meeting at Pennsylvania State College, June 8-11. Secretary, Calvin W. Rice, 33 West 39th St., New York City.

American Institute of Electrical Engineers. District meetings at Milwaukee, Wis., March 14-16, and Providence, R. I., May 4-7. Annual summer convention at Cleveland, Ohio, June 20-24. Secretary, F. L. Hutchinson, 33 West 39th St., New York.

American Boiler Manufacturers Association. Annual convention at the Greenbrier Hotel, White Sulphur Springs, W. Va., May 23-25. Secretary, A. C. Baker, 801 Rockfeller Building, Cleveland, Ohio.

American Society for Testing Materials. Annual meeting at Chalfonte-Haddon Hall, Atlantic City, N. J., June 20-24. Secretary, C. L. Warwick, 1315 Spruce St., Philadelphia, Pa.

American Water Works Association. Annual convention at the Hotel Peabody, Memphis, Tenn., May 2-6. Secretary, Beekman C. Little, 29 West 39th St., New York City.

American Welding Society. Annual meeting in New York City, Apr. 27-29. Secretary, M. M. Kelly, 33 West 39th St., New York City.

Association of Iron and Steel Electrical Engineers. Annual convention in Pittsburgh, Pa., June 20-24. Managing Director, John F. Kelly, Empire Building, Pittsburgh.

Fifth Annual Midwest Bituminous Coal Conference. At Purdue University, Lafeyette, Ind., Apr. 14-15. Secretary, W. A. Knapp, Engineering Experiment Station, Purdue University, Lafayette, Ind.

National District Heating Association. Annual convention at the William Penn Hotel, Pittsburgh, Pa., June 14-17. Secretary, D. L. Gaskill, Greenville, Ohio.

National Electric Light Association. Annual convention in the Atlantic City Auditorium and Convention Hall, Atlantic City, N. J., June 6-10. Secretary, A. Jackson Marshall, 420 Lexington Ave., New York City.

SECTION MEETINGS

A.S.M.E., Metropolitan Section. Power Division meeting in Room 501, Engineering Societies Building, March 22 at 8 p.m. Subject: "Some Notes on the Performance of Boiler Furnaces," A. T. Brown.

A.S.M.E., Providence Section. Meeting in the Society Rooms, Apr. 5 at 8 p.m. Subject: "Pure Air," Ely C. Hutchinson.

N.A.P.E., Philadelphia Locals. All-day meeting in conjunction with other engineering organizations, to be known as "Power Engineers' Day," at the Penn Athletic Club, Apr. 2. Technical sessions and entertainment.

G. L. Knight, Vice-President of Brooklyn Edison Company

GEORGE L. KNIGHT, mechanical engineer of the Brooklyn Edison Company since 1923, has just been elected vice-president in charge of mechanical operations.

A graduate of Drexel Institute, Mr. Knight joined the Brooklyn Edison Company in 1905 as chief draftsman. Three years later he became designing engineer in charge of all design and building construction. In 1922 he was

Blank & Stoller

made chairman of the engineering committee responsible for the design and erection of the Hudson Avenue generating station, and a year later he was appointed mechanical engineer of the company in charge of all mechanical and civil engineering.

Mr. Knight is a past-president of the Brooklyn Engineers Club and was formerly a manager and vice-president of the American Institute of Electrical Engineers. He is a trustee of the United Engineering Trustees, Inc., and a director of the Engineering Foundation. He is also a member of the American Society of Mechanical Engineers, National Electric Light Association and Engineers Club of New York.

Burrows Sloan Dead

BURROWS SLOAN, chairman of the board of the General Refractories Company, Philadelphia, Pa., died early Sunday morning, Feb. 28. He was 54 years old. Following his graduation from Princeton University in 1899, Mr. Sloan was employed by the Reading Company, and later became associated with the Harbison-Walker Refractories Company in Pittsburgh. In 1911, with the late Governor Sproul of Pennsylvania, he organized the General Refractories Company at Philadelphia. He became president of the company in June, 1925, and was named chairman of the board in April, 1931.

Personals

A G. CHRISTIE, professor of mechanical engineering at Johns Hopkins University, has been requested by the Mayor of Baltimore, Md., to draft specifications for the appointment of smoke inspectors under the new smoke abatement ordinance of the city.

HARRY C. SMITH, of Idaho, has been appointed assistant chief engineer of the Federal Power Commission. Since 1913 Mr. Smith has been in the service of the War Department, Engineer Department at Large. His experience in hydro-electric engineering extends over a period of eighteen years, during which he made extensive studies of the power sources of the Tennessee and Cumberland rivers and tributaries.

FLOYD L. CARLISLE, chairman of the board of the Niagara Hudson Power Corporation, was elected first chairman of the Consolidated Gas Company of New York on Feb. 26. GEORGE B. CORTELYOU was re-elected president for the 24th time. Mr. Carlisle is a director of all the major companies in the Consolidated Gas group.

A. E. BALLIN, formerly president of the McIntosh & Seymour Corporation, Auburn, N. Y., has been appointed vice-president in charge of sales and engineering of the Nordberg Manufacturing Company, Milwaukee, Wis.

IRVING LANGMUIR, noted chemist and physicist, and associate director of the General Electric Company research laboratories, is this year's winner of the *Popular Science Monthly* annual award of $10,000 for notable scientific achievement. The award, together with a gold medal commemorating it, was presented to Dr. Langmuir on Feb. 29 in New York City.

H. HOBART PORTER, president of the American Water Works & Electric Company and chairman of the board of the West Penn Electric Company, has been re-elected chairman of the Engineering Foundation. GEORGE W. FULLER, consulting engineer of New York City, was chosen first vice-chairman, and DR. C. E. SKINNER, assistant director of engineering for the Westinghouse Electric & Manufacturing Company, second vice-chairman. D. ROBERT YARNALL, vice-president and treasurer of the Yarnall-Waring Company, Philadelphia, and GEORGE D. BARRON, mining engineer of Rye, N. Y., were elected to the executive committee. DR. ALFRED D. FLINN continues as secretary and director.

H. A. VAN NORMAN, general manager and chief engineer of the Los Angeles (Calif.) Department of Water and Power, was honored recently on the completion of 25 years of public service. At a meeting of the board Feb. 18, he was presented with a 25-year service pin.

How's Business?

ALTHOUGH February showed a further sharp decline in almost all indicators of industrial and trade activity, that month may prove the most important in the whole period of depression in its contribution toward recovery. The strengthening of the banking structure has eased the domestic credit strain and March sets in with fairly hopeful signs that the acute stage of the financial crisis has been safely passed. Building figures begin to look a little better, especially in the public construction classification. Release of automotive demand and some resumption of railroad buying are expected to supply the postponed seasonal stimulus to steel. After the Ides of March have come and gone it should be possible to tell whether the forces of credit expansion have begun to operate and the business tide to turn. — *The Business Week*, March 9.

Business Notes

BADENHAUSEN CORPORATION, Cornwells Height, Pa., announces the election of the following officers and directors: F. H. Daniels, president and director; James W. Armour, vice-president and director; William N. Way, secretary-treasurer and director; E. G. Stoler, assistant treasurer and director; and David K. Beach, director. Messrs. Daniels, Armour and Beach are also officials of the Riley Stoker Corporation, Worcester, Mass. The company states that John Phillips Badenhausen has severed his official connections with the Badenhausen Corporation.

GOULDS PUMPS, INC., Seneca Falls, N. Y., announces that H. S. Fredenburgh, associated with the company for more than twenty years, has resigned as secretary and comptroller. Seabury S. Gould, second vice-president, also becomes secretary and succeeds the late William D. Pomeroy as a member of the board of directors. Hamilton Garnsey, Jr., has been appointed assistant to the president.

WORTHINGTON PUMP & MACHINERY CORPORATION, Harrison, N. J., announces the following changes in personnel: C. E. Wilson, for the past nine years general sales manager, has been made vice-president in charge of industrial relations; Clarence E. Searle, general representative in charge of sales for Allis-Chalmers Manufactuing Company for the past seventeen years, has been appointed vice-president in charge of sales; William H. Baumes, treasurer for the past fourteen years, has retired; Charles N. Barney, secretary and general counsel, has also been made treasurer; A. L. Prentice, formerly assistant comptroller, is now assistant treasurer; and Frank D. Talmadge, formerly of the counsellor's staff, has been appointed assistant secretary.

DUNBAR ENGINEERING COMPANY, representing the Edward Valve & Manufacturing Company, East Chicago, Ind., has removed its New York City office from 122 West 42nd Street to 21 West Street.

WEBSTER TALLMADGE & COMPANY, New York City, announce the appointment of John S. Webb as general sales manager. Mr. Webb was formerly associated with Alfred Kellogg, consulting engineer of Boston, and prior to that was northeastern sales manager for the Herman Nelson Company.

Trade Catalogs

INSULATION—"Jointite Cork Products" is the title of a new catalog published by the Mundet Cork Corporation, 450 Seventh Ave., New York City, which covers the uses of cork for insulation purposes. Included in the catalog are data, specifications, tables and charts on refrigeration, sound-proofing, heat prevention and conservation, vibration deadening and condensation prevention.

ELECTRICAL EQUIPMENT — General Electric Company, Schenectady, N. Y., has just issued the following new bulletins: GEA-1372A on electric steam generators; GEA-885B on two- and three-phase super-synchronous motors; GEA-1123A on outdoor switching equipment; and GEA-1262B on thrustors.

AIR FILTERS—Changes and improvements in the "Norblo" continuous operating air filters are described and illustrated in Bulletin No. 500-1 just issued by the Northern Blower Company, West 65th St., South of Denison, Cleveland, Ohio.

TOOLS—J. H. Williams & Company, 75 Spring St., New York City, announce that the new 21st edition of their complete catalog on industrial tools is now ready for distribution. This 216-page illustrated volume includes descriptions of all recent additions to the company's line, among which are socket wrenches and chain pipe tongs.

CHAIN DRIVES—A detailed description of "Rex" roller chains and sprockets is contained in the attractively illustrated catalog (No. 440) just published by the Chain Belt Company, 1600 West Bruce St., Milwaukee, Wis. Full engineering data is given in the book, including horsepower, velocity and application charts and tables, diagrams and specifications, and information on operation and maintenance.

NEW PLANT CONSTRUCTION

COMPILED BY THE McGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

Calif., Los Angeles—Board of Supervisors, Los Angeles Flood Control District, 202 North Broadway, will receive new bids until March 21 for construction of San Gabriel Dam No. 2 including three pumps, six to ten inch, ten compressors, 300 to 600 ft. capacity, six cranes, various capacities, four hoists, etc. Estimated total cost $2,000,000 to $3,000,000.

Conn., Hartford—Highland Ice Co., 330 Hudson St., awarded contract for construction of a 1 story, 50 x 125 ft. artificial ice manufacturing plant to Thomas Bogan, 50 Riggs Ave., West Hartford. Estimated cost $75,000.

Conn., Middletown—Norbert King, 20 Boston Road, awarded contract construction of a 1 story, 40 x 90 ft. ice manufacturing plant to O'Brien Bros. Estimated cost $40,000.

Conn., New Britain—Southern New England Ice Co., R. C. Hadley, Gen. Mgr., Corbin Pl., will receive bids about March 7 for construction of an artificial ice plant near Corbin Place. Brutus Gunlach, 101 Park Ave., New York, is architect. R. B. Engineering Co., 11 West 42nd St., New York, is engineer.

Fla., Pensacola—Bureau of Yards & Docks, Navy Department, Washington, D. C., will receive bids until March 9 for furnishing and installing sewer and drain piping, manholes, sewerage reservoir and pump house, etc., for sewer and storm drainage systems at Naval Air Station (Corry Field) here. Spec. 6506. Estimated cost $75,000. Motor driven sewage and sump pumps with control equipment will be furnished by general contractor.

Conn., West Haven—Hygienic Ice Co., 881 State St., receiving bids for a 1 story, 60 x 90 ft. ice manufacturing plant on Elm St. Estimated cost $40,000. Private plans.

D. C., Washington — Bureau of Standards, awarded contract for addition to dynamometer building to George E. Wyne, Washington. $43,000.

Md., Baltimore—Northway Apartment Co., I. C. Goldstein, Pres., Calvert Bldg., awarded contract for construction of a 10 story apartment building at Charles St. and Bishops' Road to Price Construction Co., Maryland Trust Bldg. $1,000,000. Steam heating system, etc., will be installed.

Mass., Great Barrington—L. H. Smith, Egremont Road, plans construction of an artificial ice plant at Lake Mansfield. Estimated cost $40,000. Architect not selected.

Mass., Norfolk — Commonwealth of Massachusetts, Department of Correction, awarded contract for alterations to power plant at State Prison Colony to Palmer Steel Co., 44 Bromfield St., Boston. Estimated cost $40,000.

Neb., Omaha—Metropolitan Utilities District, 18th and Harney Sts., having preliminary plans prepared for construction of water gas plant, 15,000,000 cu.ft. capacity, ultimate 30,000,000 cu.ft. C. D. Robinson, c/o owner, is chief engineer.

N. J., Orange—Public Service Electric & Gas Co., Terminal Bldg., Newark, plans improvements to plant recently acquired, also extensions to electric distribution system. Estimated cost $40,000.

N. Y., New York—Department of Hospitals, Municipal Bldg., having preliminary plans prepared for addition to power plant, conveyor shaft, soot collector house, service tunnels, etc., for Bellevue Hospital at First Ave. and 28th St. Estimated cost $200,000. C. B. Meyers, 31 Union Sq., is architect.

N. C., Roanoke Rapids — Sanitary District Board, will receive bids until March 14 for improvements to water and sewage systems, including automatic sewage pumping station, etc. Spoon & Lewis, Greensboro, are engineers.

Pa., Nanticoke—Pure Ice Co., Mill St., plans remodeling old foundry building on Mill St. and installing machinery for making artificial ice. $200,000.

Pa., South Donora—U. S. Engineer, received lowest bid for construction of two power houses and administration buliding for Lock and Dam No. 4 from H. Miller & Sons Co., 2565 Fifth Ave., Pittsburgh. $17,900.

Tex., Wellington — Roy Purdue, has been granted franchise by City for supplying gas and building system. Plans include installation of distribution system, booster plant, etc. Estimated cost $35,000. Private plans.

Utah, Murray—City voted $35,000 bonds for completing new hydro-electric plant. Bledsecker & Bledsecker, Murray, are engineers.

Wash., Ellensburg — Bureau of Reclamation, Denver, Colo., will receive bids until April 4 for furnishing and erecting two 45 in. diameter plate steel penstocks, each approximately 469 ft. in length for Wippel pumping plant, Kittitas Division, Yakima project here.

Wis., Cedar Grove—Town, will receive bids until March 11 for construction of sewer and waterworks systems including reservoir, tank, piping, etc. McMahon Engineering Co., Menasha, is engineer. Bids will be received later for deep well turbine pump, 350 g.p.m. pump motors, auxiliary gas engines, automatic controls, etc.

Man., Winnipeg—City, c/o P. Petersen, Clk., will soon receive bids for heating, ventilating and electrical work, etc., for new civic auditorium at St. Marys St. and The Mall. $150,000. Estimated total cost $1,000,000.

Ont., Port Arthur—Farmers Association, E. T. Ross, 47 Balsam St., Chn., plans construction of a cold storage plant. Estimated cost $50,000. Interested in prices on equipment.

Ont., St. Thomas—City awarded contract for supply and installation of a 30 hp. motor driven centrifugal pumping unit for city waterworks, to Marland Engineering Co., Montreal, Que.

Equipment Wanted

Electrical Equipment—Chicago, Ill.—U. S. Engineers Office, plans to purchase electrical equipment for Brandon Road, also for Dresden Island Lock. No date set for bids.

Motor—Portsmouth, N. H.—Bureau of Supplies & Accounts, Navy Department, Washington, D. C., will receive bids until March 22 for motor with reducing gear and brake for hydraulic steering gear, control apparatus and spares; motor with reducing gear for hydraulic power plant and spares for Navy Yard here. Sch. 7603.

Pump—San Diego, Calif.—Bureau of Supplies & Accounts, Navy Department, Washington, D. C., will receive bids until March 22 for one centrifugal horizontal pump for Navy Yard here. Sch. 7619.

Pump — Boston, Mass. — Boston Harbor Co., 545 Hanover St., plans to purchase a 7½ x 6 x 10 duplex pump.

Pump and Electric Motor—Meadville, Pa.—City, c/o H. Ellsworth, Supt. of Water & Light Department, will receive bids March 22 for one 500 g.p.m. centrifugal pump and electric motor.

Pumps — Islington, Ont. — Township of Etobicoke, W. H. Walker, Engr., plans to purchase three vertical raw sewage pumps.

Pumps and Motors—Waterford, Conn.—William MacKenzie, 390 North Main St., Wallingford, Engr., will receive bids until March 12 for furnishing and installing pumps and motors in connection with waterworks. Estimated cost to exceed $15,000.

Refrigeration Equipment—New York—Department of Mental Hygiene, State Office Bldg., Albany, will receive bids until March 16 for refrigeration equipment, etc., at Pilgrim State Hospital, Pine Aire Station, Suffolk County, Long Island.

Turbine, Generators, etc.—Ukiah, Calif.—Pacific Gas & Electric Co., 245 Market St., San Francisco, plans installation of 8,500 hp. hydraulic turbine and new generator to replace two 2,500 hp. generators, also rearrangement of interior layout to include new circuit breakers, switchboards and related equipment, two new 2,000 kw. transformers, etc., in connection with reconstruction of Potter Valley power house near here.

Industrial Projects

Calif., Los Angeles — Harry Siskin, 5702 Olympic Blvd., completed plans for construction of a 1 story factory building at 62nd St. near Central Ave. Estimated cost $75,000. John M. Cooper, 321 Rives-Strong Bldg., is architect. Purex Chemical Co., 647 East Gage Ave., is lessee.

Conn., New Haven—Berger Bros., 35 Derby Ave., receiving bids for construction of a 5 story, 40 x 120 ft. factory for the manufacture of surgical apparatus. Estimated cost $75,000. Douglas Orr, 956 Chapel St., is architect.

Ill., Chicago—A. B. T. Manufacturing Co., 3311 Caroll Ave., awarded contract for a 2 story, 36 x 90 ft. addition to factory for the manufacture of coin operating machines to Gus Lindell, 4601 North Ave. Estimated cost $80,000.

Ga., Rossville—Peerless Woolen Mills, will receive bids until March 15 for construction of a 3 story, 100 x 300 ft. warehouse and processing plant. Estimated cost $100,000. W. H. Sears, James Bldg., Chattanooga, Tenn., is architect. Machinery will be purchased.

Mass., Gardner — Kuniholm Manufacturing Co., 58 Main St., manufacturers of baby carriages, plans to rebuild plant recently destroyed by fire. Estimated cost $45,000. Private plans.

Mass., Milford—Niro & Niro Co., 61 Main St., plans reconstruction of factory destroyed by fire. Estimated cost $40,000. R. A. Cook, 57 Prospect St., Milford, is architect. Work will be done by separate contracts.

Mass., Weymouth — Crawford Machine Co., Central Ave., plans reconstruction of factory destroyed by fire. Estimated cost $50,000. Private plans.

N. Y., Buffalo—Irving Air Chute Co., 374 Pearl St., awarded contract for construction of a 1 story, 82 x 162 ft. factory and office at 1668 Jefferson St., to John W. Cowper Co., Rand Bldg. Estimated cost $40,000.

O., Cleveland—Industrial Rayon Corp., H. S. Rivitz, Pres., West 98th St. and Walford Ave., plans completed for a 1 story, 80 x 430 ft. addition to factory. Estimated cost $300,000. Christian Schwarzenberg & Gaede Co., Union Bldg., are architects.

O., Lisbon—American Vitrified Products Co., 15 Broad St., Akron, plans extensions and improvements to plant. Plans include kilns to be erected later in year, new loading dock, storage building, installation of conveyor system together with improved pipe turners and revolving tables; automatic coal hoist; electric drills for clay mines, etc., here. Estimated cost $100,000.

Pa., Indiana—Diamond Glass Ware Co., H. W. Thomas, 565 Water St., plans to rebuild glass plant, 1 story, 88 x 150 ft. destroyed by fire on College Ave. Engineer not selected. Maturity about April.

Pa., Pittsburgh—M. Lanz Brick & Tile Co., 2907 Carson St., awarded contract for construction of a 1 story, 40 x 60 ft. brick plant at Jane and 34th Sts., to Reliance Steel Co., Rankin. Estimated cost $50,000.

Va., Norfolk—Victory Motor Car Co., plans construction of a 1 story, 225 x 800 ft. factory for the manufacture of automobiles. Estimated cost $250,000. Phil. Moser, Norfolk, is architect. Possible maturity 1933.

Tex., New Braunfels — Texas Angora Goat Raisers Association, Rock Springs, c/o B. Davis, Rio Frio, plans construction of a mohair and woolen mill here. Complete new machinery and equipment will be purchased and installed here. City of New Braunfels proposes to give building site and finance project.

Wis., Kaukauna — Thilmary Pulp & Paper Co., receiving bids for a 1 story, 135 x 200 ft. paper bag mill. Estimated cost $40,000. Private plans.

Ont., Toronto — Electresteem Radiator Company, Ltd., plans construction of plant for the manufacture of stoves, furnaces, ranges, etc.